A CASE STUDY OF DISTAL TIBIAL FRACTURES MANAGED WITH LOCKING COMPRESSION PLATE USING MIPO TECHNIQUE

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CERTIFICATE

This is to certify that this dissertation titled **"A CASE STUDY OF DISTAL TIBIAL FRACTURES MANAGED WITH LOCKING COMPRESSION PLATE USING MIPO TECHNIQUE"** is a bonafide work done by **Dr.P.VANAJ KUMAR.,** Post graduate student of the Department of Orthopaedics, Tirunelveli Medical College Hospital, Tirunelveli, during the academic year 2012 – 2015. This work did not form the basis for the award of any degree previously.

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This is to certify that the work entitled **“A CASE STUDY OF DISTAL TIBIAL FRACTURES MANAGED WITH LOCKING COMPRESSION PLATE USING MIPO TECHNIQUE**” is a bonafide work done by **Dr. P. VANAJ KUMAR** in the Department of Orthopaedics, Tirunelveli Medical College, Tirunelveli.

He has completed the necessary period of stay in the Department and has fulfilled the conditions required for submission of this thesis according to the university regulations. The study was undertaken by the candidate himself and observations recorded have been periodically checked by us.

Recommended and forwarded.

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DECLARATION

I, **Dr. P. VANAJ KUMAR,** solemnly declare that the dissertation entitled "**A CASE STUDY OF DISTAL TIBIAL FRACTURES MANAGED WITH LOCKING COMPRESSION PLATE USING MIPO TECHNIQUE**" has been prepared by me under the able guidance and supervision of my guide **Prof.Dr. Elangovan Chellappa, M.S.ORTHO., D.ORTHO., Prof. & HOD,** Department of Orthopaedics and Traumatology, Tirunelveli Medical College, Tirunelveli, in partial fulfillment of the regulation for the award of **M.S. (ORTHOPAEDIC SURGERY)** degree by the Tamilnadu Dr. M.G.R. Medical University, Chennai in the examination to be held in April 2015.

This work did not form the basis for the award of any other degree or Diploma to me previously from any other university.

Place: Tirunelveli

Date: DR. P. VANAJ KUMAR

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1. INTRODUCTION

Increased incidence of Road Traffic Accidents claims most of human mortality and morbidity in the current age. Hence, it forms the major epidemic of Modern world. Of these, fractures of distal tibia have been difficult to treat. In this era of increasing life expectancy, there is a rise of elderly population which, increases the incidence of these fractures in osteoporotic bones, adding to the morbidity. Due to the proximity of these fractures to the ankle, regaining full ankle movement may be difficult. Soft-tissue damage, comminution and fracture extension into the ankle joint lead to unsatisfactory results in many cases regardless of the treatment modality.

Better understanding of the injury patterns, availability of better implants, the concept of early surgical fixation and early postoperative mobilization of joint all have convincingly improved the functional outcome of the patient to a large extent.

Main challenges encountered in the treatment of distal tibia fractures are

- these are high energy fractures

- associated with extremely damaged soft tissue envelope

- increased incidence of compound injuries

-increased skin complications following surgery

-comminution of the metaphysis and articular surface makes anatomical reduction difficult.

The resulting incongruency of articular surface leads to early secondary OsteoArthritis.

In metaphysis the fixation is less satisfactory resulting in early loosening of the implant. Achieving rigid fixation in comminuted fractures is difficult due to poor purchase and hence the fixation is less optimal to allow weight bearing or even early mobilization. Initially conservative treatment with Plaster Of Paris was advocated as a treatment option. But it leads to high incidence of malunion and stiffness of ankle joint. Also prolonged recumbency resulted in high incidence of thromboembolic diseases and pneumonia.

Open reduction and internal fixation with plate osteosynthesis lead to skin necrosis and infection in > 40% of patients eventually leading to malunion and implant failure. Intramedullary devices give inadequate stability due to wide medullary cavity leading to implant failure and screw breakage. For compound fractures, initial treatment with external fixator for wound care followed by a definitive mode of internal fixation was advocated. This involves multiple procedures which increased economical and mental stress for the patients.

But minimally invasive plating offers the advantage of fracture fixation without disturbing the soft tissue cover; less chances of infection, early mobilization of patient. Using a locking compression plate reduces the tendency for varus collapse and at the same time affords better stability. The successful management of these injuries, demands a thorough knowledge of fracture personality and technical aspects of fracture fixation; and a tailored post-operative management.

2. AIM:

• To discuss the management of fractures of distal tibia

• To evaluate the biomechanical and biological advantages of

Locking compression plates

• To evaluate clinical, functional and radiological outcomes after minimally invasive plate osteosynthesis using distal tibial locking compression plates.

3. REVIEW OF LITERATURE:

Hansmann from Hamburg did the first plate osteosynthesis in the year 1886. During the 1950’s the AO / Association for the Study of Internal Fixation standardized the use of plating systems. Then the main goal of fracture treatment was to restore the function of the injured limb by providing the bone with primary strength through stable internal fixation. This resulted in a decrease of limb deformities and joint stiffness.

The original AO/ASIF technique was based on the compression principle using plates and screws. The dynamic compression plates provided axial compression of the fracture (Fig. 1). Thus perfect fracture reduction and compression using lag screws resulted in primary bone healing without visible callus. So, even the smallest fragments were reduced to restore the exact anatomy, often damaging the vitality of bone and soft tissues. This highly traumatic technique ultimately resulted in delayed bone healing, nonunion, and increased chances of infection.

Fig. 1 : Dynamic Compression Plate.

This led to a change over from the concept of absolute stability to a newer concept of bridge plate which provides relative stability. The smaller fracture fragments are left untouched and bridged by anchoring the plate only to the proximal and distal main fragments. Lag screws are not used to achieve inter fragmentary compression. Hence the fracture unites by secondary bone healing with the production of thick external callus.

Preserving the circulation at the fracture zone was the main concern than achieving anatomical reduction and stable fixation. Ganz[3] named this newer technique as **biological plate osteosynthesis**.

This indirect reduction technique with bridging stabilization did not expose the fracture site and hence was less traumatic and more biological resulting in good bone and soft tissue healing.

The evolution of Bone Plates:

Conventional plating techniques aimed to press the plate against the bone fragments with high compressive force, to create a stable bone–implant construct. It required adequate number of bicortical screws to achieve adequate anchoring force. Lüthi et al.[7] showed that the periosteal blood supply was severely compromised by this highly stable plate-bone construct. Gautier et al,[2] Jörger,[6] and Vattalo,[16] showed that these circulatory disturbances can lead to bone necrosis. This can be managed only by reaming the dead bone. This process may temporarily perforate the bone.

Later it was proposed that reducing the contact surface of the plate and bone minimized the damage to cortical blood supply. Based on this concept a special plate which reduces the contact surface by more than

50% compared to conventional DCP[10] was designed and was named as Limited Contact DCP (Fig. 2). Even in LC-DCP, the principle of compressive forces against the bone was still present.

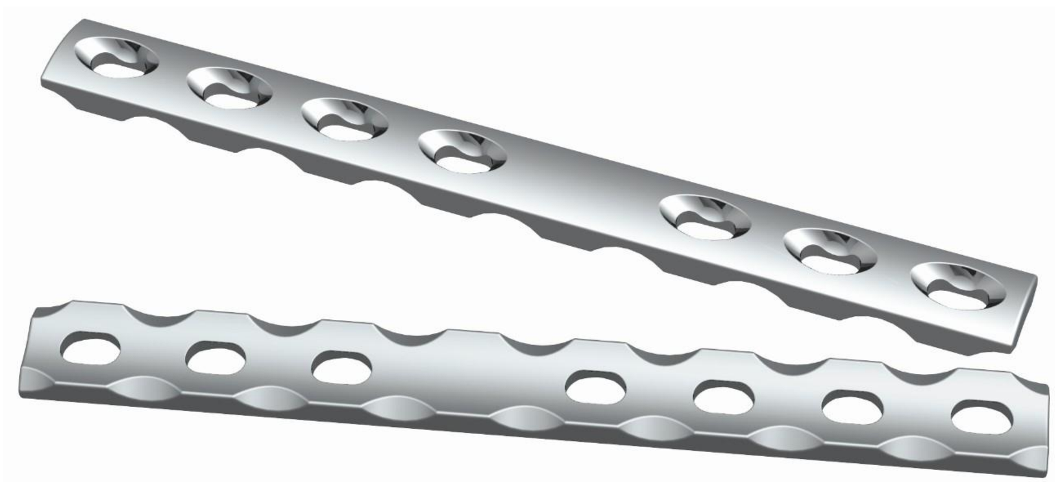


Fig. 2: Limited Contact Dynamic Compression Plate.

Only the use of an angular-stable implant can obviate the need for the frictional forces between plate and bone. This kind of device is an internal fixator placed under the skin surface. The first internal fixator was developed in the 1970s in Poland.[11] Then the Association for the Study of Internal Fixation (ASIF) developed "The point contact fixator" (Fig. 3). Angular stability was achieved in PC-FIX by a conical connection between plate holes and screw heads[15].

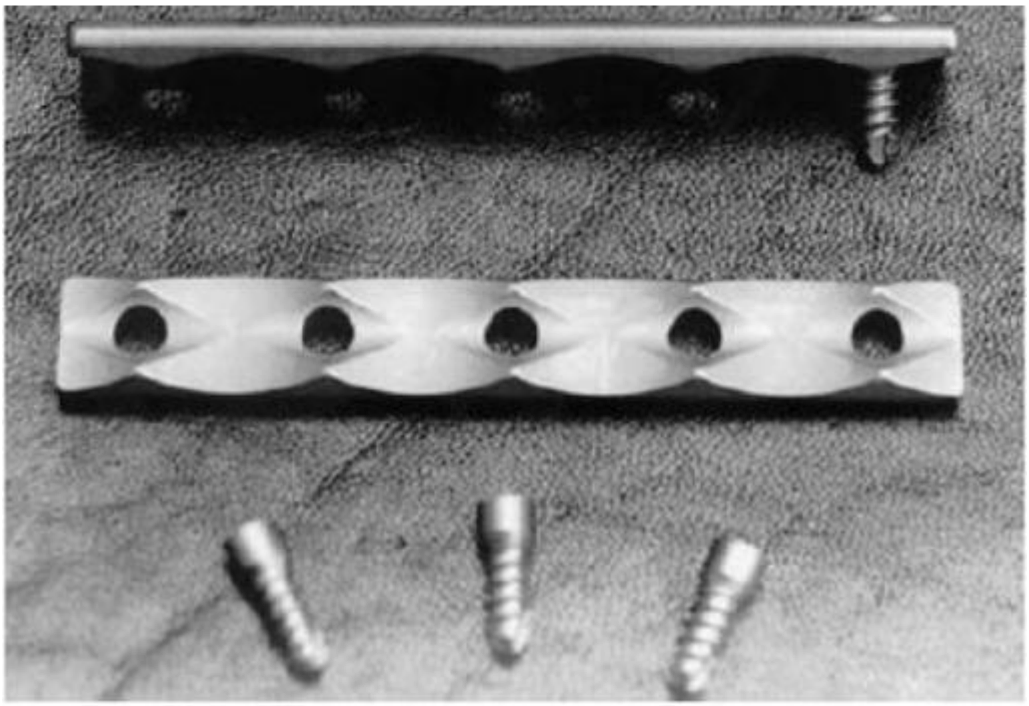


Fig. 3: Point Contact Fixator (PC-Fix).

Since this conical connection between plate and screws did not produce extreme angular stability, a new thread connection between screw head and plate hole with high angular stability was developed. This system provides stable anchor without contact between bone and force carrier and is called as the internal fixator system.

The internal fixator system includes[4,13]

- The less invasive stabilization system (LISS) (Fig. 4)

-The locking compression plate (LCP) (Fig. 5).

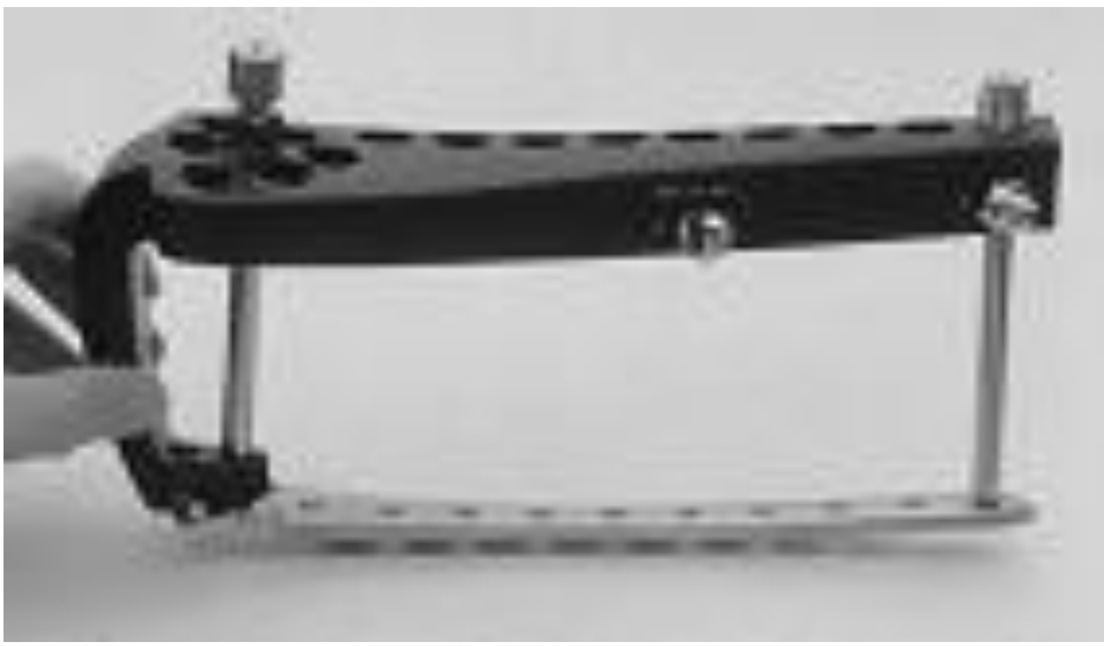


Fig. 4: Less Invasive Stabilization System.

Fig. 5: Locking Compression Plate.

The conventional cortical screws were used as anchoring screws but these locking head screws act as Schanz screws between the bone and the force carrier.[13]

In conventional plating, with axial compression there exists a transverse strain on the bone. But in case of internal fixators load transfer occurs through the locking head screws.

Locking compression plates:

They bear a new screw-hole geometry called the combi- hole, which can be filled with a conventional cortical screw or an angular-stable locking head screw. At present almost all plate designs are available with this combi-hole for use as internal fixators in metaphyseal fractures [9].

While the cortical screws were used only as reduction screws, the locking head screws are used as implant set screws. For a stable construct at least three locking head screws must be used in each main fragment. The screws must be bicortical in osteoporotic bone.

The drill bits used for LHS are

2.8-mm for 3.5 systems

4.3-mm for 4.5 systems

The drill guide can also be locked in the angular-stable hole of the plate.

Indications for these internal fixator systems include, metaphyseal fractures of

the proximal and distal humerus,

the distal radius and the distal tibia.

The biological advantages of this new system are

- Preservation of the periosteal blood supply
- Improved fixation in poor metaphyseal or osteoporotic bone
- Facilitation of minimally invasive and percutaneous techniques.

Minimally invasive plate osteosynthesis:

Distal tibia fractures with or without intra articular extension, are difficult fractures to manage. Distal tibia is circular in cross section and has a thin cortex while the diaphysis is triangular with thicker cortex.

Since intramedullary nail is designed only for snug fit at the shaft, it cannot provide stability at the distal tibia.[3,16] Complications of interlocking nailing in distal tibia fractures are

- malunion upto 29%
- implant failure upto 39%.[1,13]

Since tibia is a subcutaneous bone 2/3 rd of its blood supply comes from periosteum. ORIF strips off this vital layer and results in

- Non union upto 35%
- Infection upto 25%.[4-7,17]

External fixators are recommended only as a temporary method of stabilization in open fractures with severe soft tissue injury.[1,18]

MIPO technique using LCP

- preserves extraosseous blood supply
- respects the osteogenic fracture haematoma
- provides a biologically friendly and stable fixation
- allows indirect reduction methods
- permits sub-cutaneous tunneling of the plate avoiding large incisions
- prevents iatrogenic injury to vascular supply of the bone[19]

- provides both angular and axial stability since it is a friction independent self-stable construct
- minimizes risk of secondary loss of reduction because of the locking mechanism between screw heads and plate holes.[12]

Comparative studies between interlocking nails and conventional plating revealed a higher incidence of axial mal-alignment and higher mean pain scores with interlocking nails (Vallier et al). But operative time and radiation exposure were significantly higher in the MIPO group.[6,8]

The MIPO group showed better functional outcome in terms of joint mobility, less post-operative pain and early return to work.[27]

MIPO with LCP also requires anatomical reduction of the fracture using indirect reduction maneuvers and image intensifier guidance, before plate fixation.

The complications like

- delayed union,
- non-union,
- prominent hardware,
- malleolar skin irritation and
- post-operative pain.[23,24,26]

result from mal-reduction and suboptimal pre contouring of the plate.

The common indications for implant removal were

- prominent hardware
- malleolar skin irritation
- pain

The use of Low profile metaphyseal Locking Compression Plates reduces hardware prominence.[23]

Polyaxial locking plates are useful options when the supramalleolar anatomy mismatches with the pre contoured plate. It provides choice of screw trajectories according to fracture pattern.[24]

The indirect reduction methods followed are

- calcaneal pin traction,
- external fixators,
- mechanical distractors[22]
- Kirschner wire used as a joystick at fracture site
- fibula fixation before tibia fixation when both are fractured at the same level.[1,23,24,28]

Routine fixation of fibula is unnecessary unless the fracture has involved the syndesmosis.

Rarely, following MIPO technique secondary procedures like bone grafting or bone marrow injection may be needed for delayed union.[29]

Prolonged injury-hospital arrival interval results in

- gross swelling,
- skin injury and
- fracture blisters.

This causes a delay in the definitive fixation of the fracture, waiting for the soft tissues to heal. But union time is not affected by this delay in surgery.[30]

Late infections occurring after one month of complete wound healing did not affect the union time (Lau et al). The patients with superficial wound infection improved with antibiotics but patients with wound breakdown and exposed implant required repeated wound debridemet and long hospital stay.[31]

Injury to saphenous nerve and great saphenous vein can be avoided by careful attention towards the placement of skin incision, dissection of vein and atraumatic placement of the drill sleeve.[26,31]

LCP removal is usually a tough task as the conical extraction devices may not work when stripping of hexagonal recess or thread happens. In such cases the removal can be completed by cutting and bending of the plate around the stripped screw.[23,32]

Thus MIPO with LCP is a highly fruitful method of treatment in distal tibial fractures, both in terms of union rate and complications rate.

4. BIOMECHANICS

Distal Tibia Locking Compression Plate:

Fig. 6: Distal Tibia Locking Compression Plate.

The locking plate system is basically similar to the traditional plate fixation methods with few improvements. Locking head screws provide fixed angle construct and improved fixation in osteoporotic bones (Fig. 7).

Fig. 7: Locking Head Screws.

1. The screws are not dependent on plate bone compression

2. Multiple screw insertion in distal fragment allows improved fixation

3. These plates are anatomically contoured to match the surface of the bone and hence intra-operative contouring is not needed.

4. Combi - holes have additional dynamic compression mode that provides options for axial compression in addition to the locking mechanism (Fig. 8).

LCP

Fig. 8: Combi holes in LCP.

CONVENTIONAL BONE PLATING VERSUS LOCKED COMPRESSION PLATING

Conventional bone plates rely on direct plate -bone and screw-bone friction to maintain the fixation. Therefore the plates must be perfectly contoured prior to application to the bone. Fracture reduction can be lost from axial loads causing excessive shear forces on the construct that are greater than the frictional loads between the bone-plate-screw construct.

The cortical screws may toggle leading to screw loosening and loss of fixation. Each screw works independently; the construct depends on a single screw's stiffness or pullout strength.

The biomechanical goal of the LCPs is to amplify the stiffness of the construct in a biological environment. The Locking plate is a fixed angle construct that does not depend on screw purchase in bone.

After locking the screw into the plate, the shear stress at the screw-bone interface is converted into compressive force by the fixed-angle construct. The load is now perpendicular to the screw axis. In order for the construct to fail under an axial load, the bone must collapse in compression. Therefore, the strength in the LCP is the sum of all the screw and plate interfaces.

Locking screws:

-have a smaller thread design

-are not used to generate plate-bone compression

-have a larger core diameter for greater bending and shear strength

-dissipate the load over a larger area of bone

-have the new Star Drive head that permits 65% greater insertion torque than hexagonal drivers.

-have a conical, double-lead thread design that enables alignment with the threads in plate hole.

The indications for LCPs :

1. Patients with poor bone quality (osteoporosis, osteomyelitis)

2. Complex juxta-articular fracture (where contouring will be difficult in the metaphyseal region)

3. fractures with difficulty in achieving adequate number of conventional screw purchase

4. Polytrauma cases (especially when the fractures cannot be anatomically reconstructed).

5. Failure of conventional plate systems (cortex or cancellous screw stripping or screw back-out)

6. Peri-prosthetic fractures

Studies in bone models show that locked screw constructs fail at higher loads compared to cortex screws. Hence they are very advantageous in osteoporotic bones.

The ideal number of locked screws on both sides of the fracture, the number of unicortical versus bicortical screws needed for stable fixation, indications for plate contouring, the effects of adding additional implants are not clearly determined at present.

It is possible to place locking plates and screws minimally invasively with fluoroscopic guidance. In humans there is little mechanical advantage in applying more than 2 locked screws on each side of the fracture.

5. ANATOMY OF DISTAL TIBIA

The distal tibia has five surfaces:

- inferior,
- anterior,
- posterior,
- lateral,
- medial.

The inferior surface is the articular surface (Fig. 9).

It is concave antero-posteriorly, and slightly convex transversely.

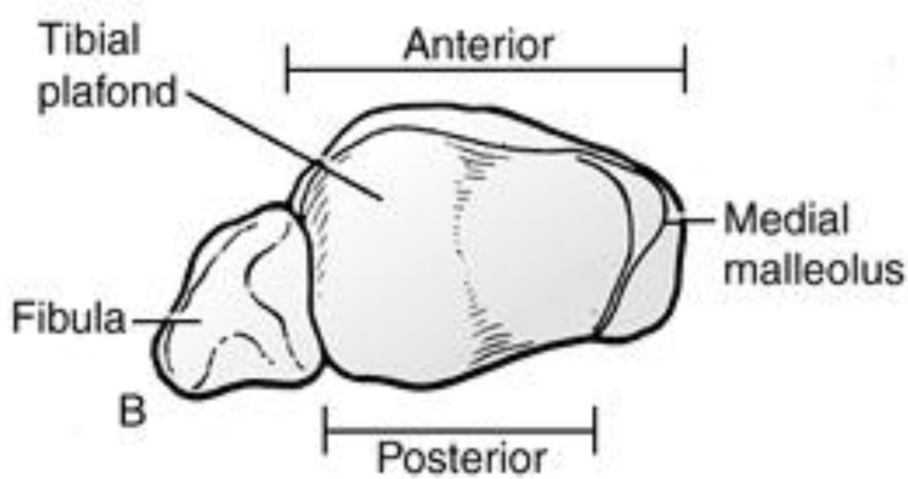


Fig. 9: Inferior Surface of distal tibia and fibula.

The anterior border of the ankle joint is higher than the posterior border.

The distal lateral border of the tibia is concave and bears anterior and posterior tubercles.

The anterior tubercle overlaps the fibula. This is the reason for the normal X-ray appearance of the tibio-fibular syndesmosis (Fig. 10).

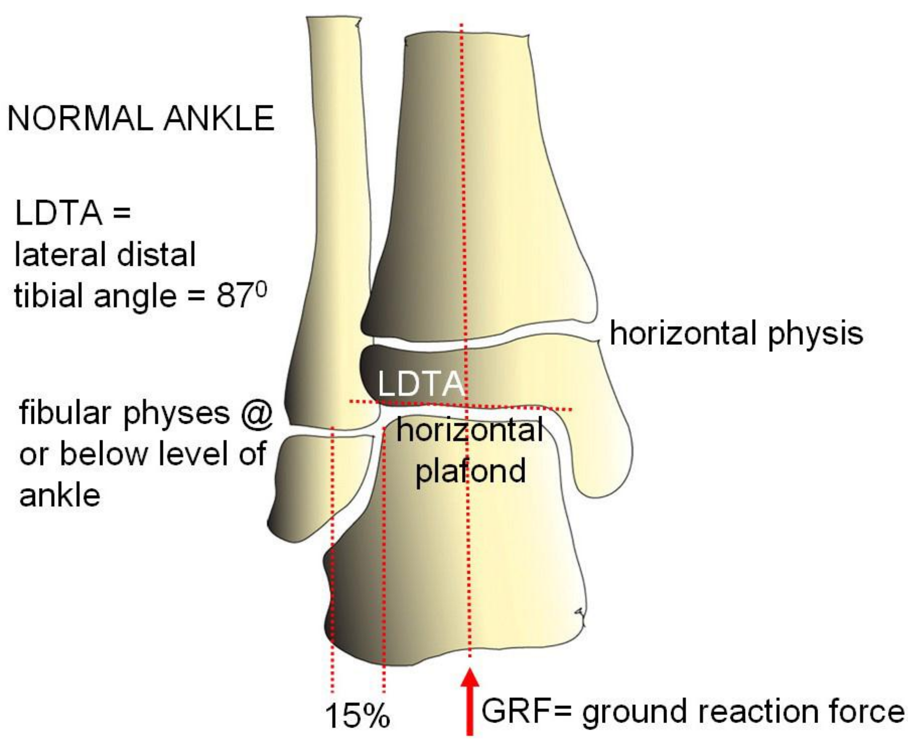


Fig. 10: Normal Ankle Joint.

The anterior tubercle bears the origin of the anterior tibio fibular ligament. In the posterior tubercle lies the attachment of the deep component of the posterior tibio fibular ligament.

The anatomy of the ankle, provides stability in dorsiflexion and mobility in plantar flexion.

Dorsiflexion stability is provided by articular contact and plantar flexion stability by the ligamentous structures.

The talar dome is narrow posteriorly and wider anteriorly.

During dorsiflexion, the fibula rotates externally to accommodate the widened anterior part of talus.

a. <u>Anatomy of Pilon Fracture</u>

Fractures of distal tibia within 5cm of the ankle joint (Fig. 11).

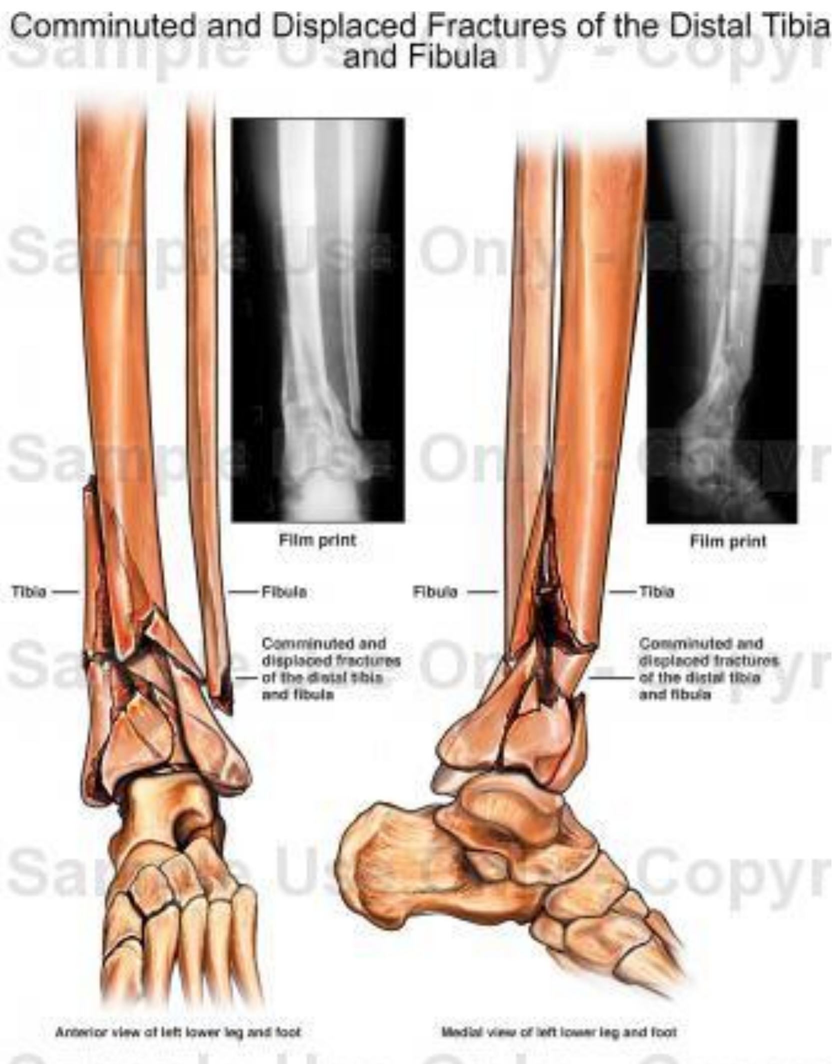


Fig. 11: Pilon Fracture.

1. Pilon fractures involve the articular weight bearing portion of the distal tibia.

2. Usually results from high energy axial load as in RTA, fall from height and rarely from low-energy rotation/torsion.

b. <u>Clinical Evaluation</u>

1. Assess vascularity – look for dorsalis pedis and posterior tibial pulses and distal capillary refill.

2. Evaluate associated soft tissue injury (swelling, blisters).

3. Look for compartment syndrome and closed degloving.

Blisters filled with blood denote more extensive skin and soft tissue damage compared to blisters filled with clear fluid.

c. Pilon Fracture Radiology

i. Antero Posterior, lateral and mortise views of the ankle (Fig. 12)

ii. Antero Posterior and lateral views of entire Tibia

iii. CT scan of ankle joint with 3-dimensional reconstruction.

X Ray and CT imaging must be done with traction applied to the limb.

Fig. 12: X Ray Ankle Mortise view.

6. CLASSIFICATION OF DISTAL TIBIA FRACTURES

Ruedi and Allgower's classification

It was the first classification that came to use.

It was widely used in literatures on distal tibia fractures until the introduction of AO classification.

It is based on the degree of articular comminution (Fig.13).

Type I - non displaced cleavage fractures of joint

Type II – displaced fractures with minimal comminution

Type III – displaced fractures with severe comminution.

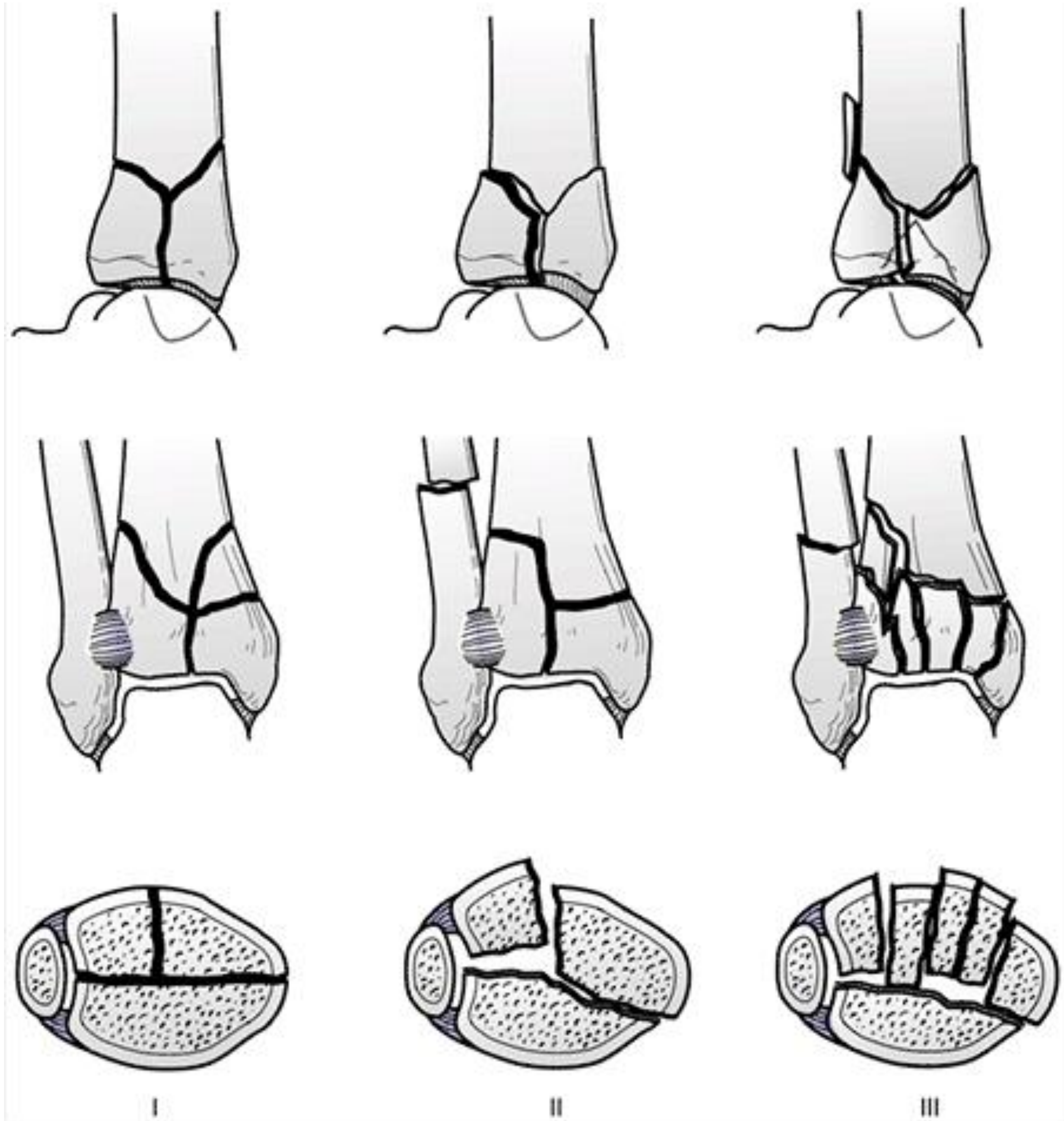


Fig. 13: Ruedi Allgower’s classification.

This classification has a prognostic significance;

Prognosis being poor as the type increases from type I to type III.

<u>AO/ OTA classification</u> is now universally used for distal tibial fractures (Fig. 14).

Type A – non-articular fractures

Type B – partial articular fractures

Type C – total articular fractures (tibial plafond fractures).

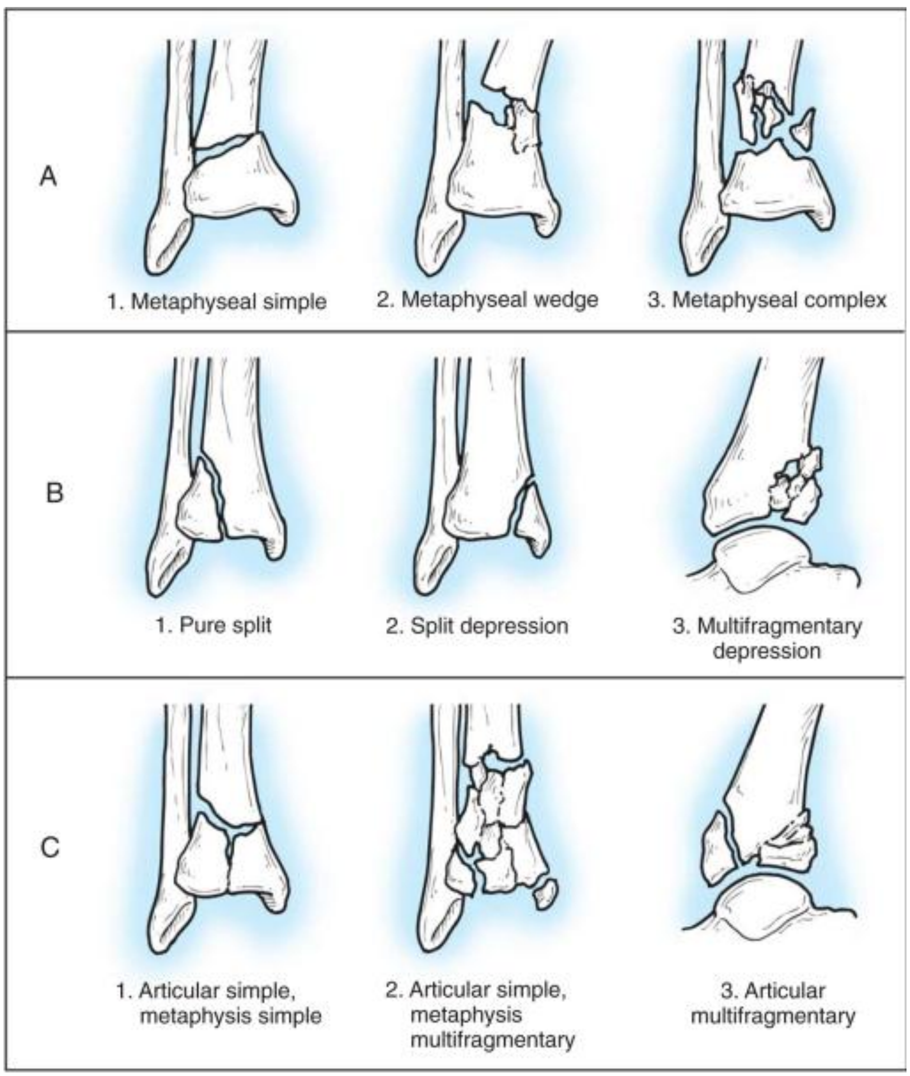


Fig. 14: AO / OTA classification.

Soft tissue injuries are classified based on

Tscherne and Gotzen classification.

Grade	Description
0	Little or no soft tissue injury
1	Superficial abrasion with local contusion in skin / muscle
2	Deep contaminated abrasion with local contusion in skin / muscle
3	Extensive crushing or contusion of skin / muscle destruction

Table 1: Tscherne classification.

Open fractures are classified as per **Gustilo and Anderson.**

Type I

- wound < 1 cm with minimal soft tissue injury

Type II

- wound >1cm with moderate soft tissue injury

Type III A

- high energy trauma with crushed tissue and contamination
- with adequate soft tissue coverage

Type IIIB

- extensive periosteal stripping and requiring soft tissue transfer

Type IIIC

- with associated vascular injury

7. <u>MECHANISM OF INJURY</u>

- Low energy rotational forces (pronation dorsiflexion injury)
- High energy axial compression forces (road traffic accident, fall from height)

Low energy injuries carry a good prognosis.

But high energy injuries with extensive soft tissue damage are more common (Table. 2).

Rotation forces	**Axial load forces**
Low energy	high energy
Slow load rate	Rapid load rate
Talus – translation	Talus- proximal displacement
Minimal articular comminution	Severe articular and metaphyseal comminution
Minimal soft tissue damage	Extensive soft tissue damage

Table. 2: Rotation forces vs Axial load forces.

Foot postion at the time of injury determines fracture pattern:

plantar flexion- posterior tibial fragment (Fig. 15),

neutral- entire articular surface (Fig. 16),

dorsiflexion- anterior fragment (Fig. 17).

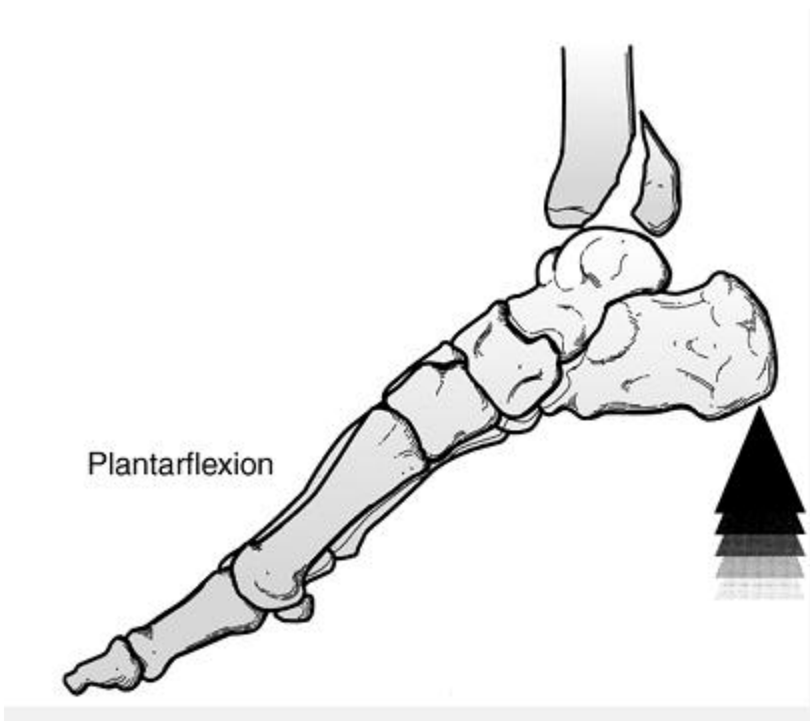


Fig. 15: Plantar flexion injury

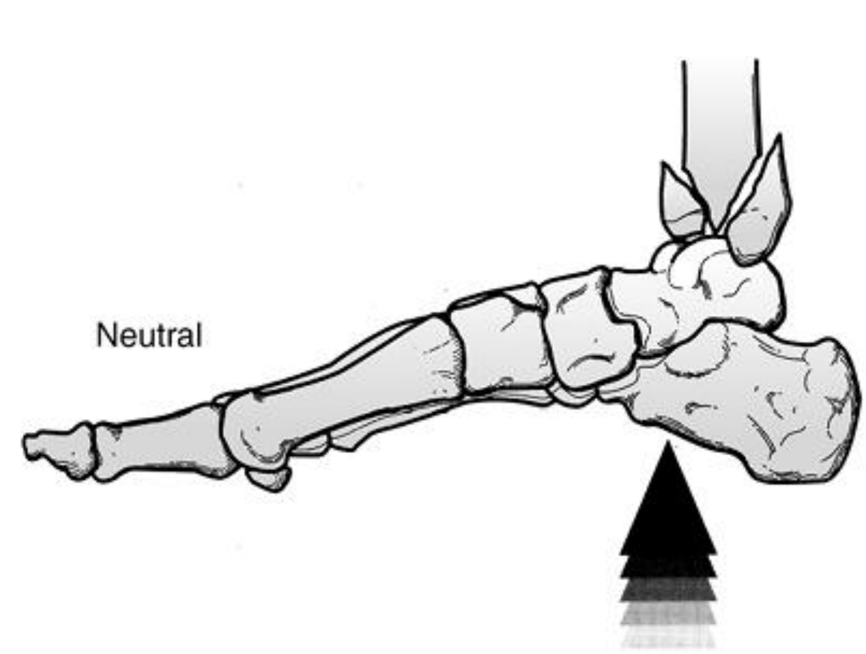


Fig. 16: Neutral flexion injury.

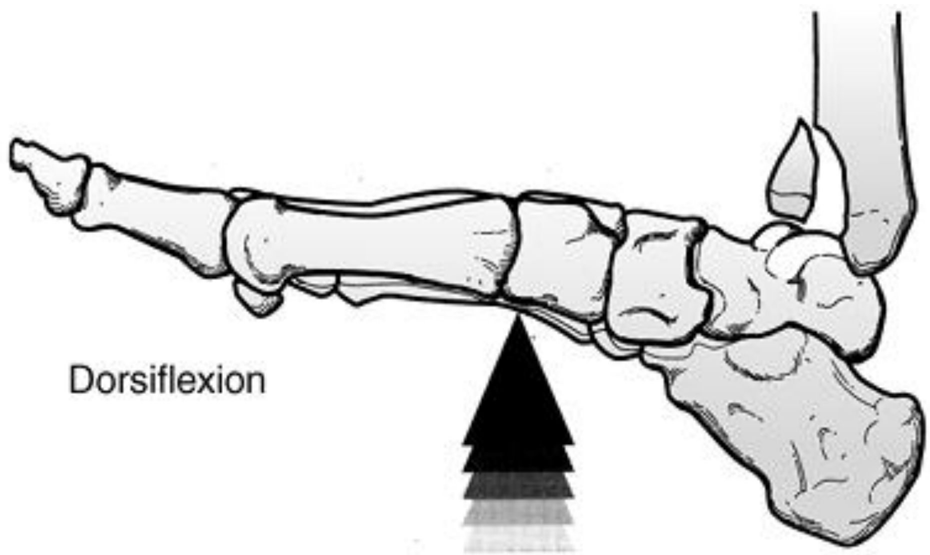


Fig. 17: Dorsiflexion injury.

8. INVESTIGATIONS

- Plain X Ray including entire Tibia AP and Lateral views.
- Plain X Ray Ankle AP, Lateral and Mortise views (Fig. 18,19).
- X Ray of contralateral ankle.
- X Ray foot AP and Oblique views.
- CT Ankle with 3 Dimensional reconstruction (Fig. 20,21,22).

Fig. 18: X Ray Ankle AP view.

Fig. 19: X Ray Ankle Lateral view.

Fig. 20: CT Ankle axial cut.

Fig. 21: CT Ankle Sagittal cut.

Fig. 22: 3-D reconstruction CT Ankle.

X Ray of the contralateral ankle may be useful as a template for articular reconstruction.

CT scan images are useful in

- Identifying the direction of fracture lines
- Determining the extent of articular comminution and impaction
- Assessing the size and displacement of articular fragments
- Planning the skin incision
- Placing olive wires and lag screws.

X Rays and CT scans must be taken with traction applied to the limb for better understanding of fracture morphology.

9. PRINCIPLES OF MANAGEMENT

The factors which play a dynamic role in management are

i. Degree of fracture displacement
ii. Extent of soft tissue injury
iii. Degree of comminution
iv. Neurovascular injuries
v. Severity of joint involvement
vi. Osteoporosis
vii. Associated ipsilateral fractures (ex: patella, tibial plateau, talus)

The main goal of fracture treatment is obtaining a stable, aligned, mobile and painless joint to reduce post traumatic osteo arthritis.

The principles of treating distal tibia fractures are

Restoring length of fibula,

Anatomic reduction of articular surface,

Medial buttress plating to prevent varus malalignment

Bone grafting for metaphyseal defects,

The objectives of treatment are

i. To restore anatomical articular surface
ii. To obtain and maintain acceptable reduction and stable fixation
iii. To achieve normal mechanical alignment
iv. To treat the associated injuries
v. To provide a stable joint
vi. To achieve fracture union
vii. To regain a functional range of ankle motion
viii. To enable pain free weight bearing.

The prognosis of fracture depends on

i. degree of depression of articular surface
ii. extent of fracture separation
iii. degree of diaphyseal and metaphyseal comminution
iv. integrity of soft tissue coverage

The various treatment options are

1. Primary internal fixation of tibia alone or both tibia and fibula in closed fractures without significant soft tissue swelling.
2. Primary internal fixation of the fibula with temporary spanning external fixation for tibia and delayed conversion to internal fixation when soft tissues permit.
3. Closed fractures with significant soft tissue swelling may be placed in calcaneal pin traction.
4. Open fractures should be taken for emergency wound debridement and ankle spanning external fixation which can later be converted to definitive fixation.

10. METHODS OF TREATMENT

i. Open reduction and internal fixation to restore articular congruency is must for an articular fracture with joint instability.

ii. Anatomical reduction and stable fixation of articular fragments is mandatory for articular cartilage regeneration.

iii. If open reduction and internal fixation is not possible due to Patient conditions skeletal traction should be applied.

In the 1960s, conservative methods like traction and cast bracing, produced better results than operative treatment, due to lack of adequate internal fixation devices. It had a high occurrence of malunion and Stiffness of adjacent joints. Also prolonged recumbency caused thromboembolic disease and pneumonia.

With the development of advanced internal fixation devices, treatment protocol changed in 1980s. Open reduction and internal fixation with buttress plates was done. Due to the poor soft tissue cover it caused skin necrosis in distal tibia which led to high chances of infection. Also low profile plate led to implant failure and eventually malunion.

Intramedullary rods were used which had inadequate stability due to wide medullary cavity in distal tibia which lead to Implant failure and screw breakage. Also varus / valgus malalignment was common in closed interlocking nailing..

External fixation can be used as either temporary or definitive fixation in open distal tibia fractures especially those associated with vascular injury. Since it is a form of Rigid fixation, delayed union was common. As it Spans the joint, chances of joint stiffness are more.

A recent advance in technology for the treatment of distal tibial fractures includes minimally invasive plate osteo synthesis using locking compression plates.

This technique offers the advantages of

- bridging fixation of various fracture patterns without disturbing the soft tissue cover
- less chances of infection
- early mobilization of patient
- reduced tendency for varus collapse
- greater stability.

Management of distal tibial fractures can be divided into two broad categories.

i. conservative treatment
ii. operative treatment

<u>In operative treatment, various modalities include</u>

i. Open Reduction Internal Fixation with buttress plate
ii. Open Reduction Internal Fixation with locking compression plate
iii. Minimally invasive plating with LCP
iv. Closed reduction & internal fixation with expert tibial locking nails.
v. Ilizarov ring fixation
vi. Uni-planar external fixation.
vii. Hybrid external fixator application

CONSERVATIVE MANAGEMENT

Considerable controversy existed as to whether conservative (or) surgical treatment leads to better results in the management of periarticular fractures of distal tibia. Early attempts at internal fixation of these complex injuries were associated with high incidence of malunion, nonunion and infection.

Because of the increased risk of complications, numerous authors concluded that closed methods were preferable to operative treatment.

With the improvement in surgical techniques, availability of better implants, prevalence of better antibiotics, the operative management has now got many recommendations in treatment of periarticular fractures of distal tibia.

The indications for conservative therapy include

i. Undisplaced (or) Incomplete fractures with intact collateral ligaments.
ii. Fractures displaced less than 5mm
iii. Elderly sedentary patients with depression less than 2 mm
iv. Impacted stable fracture in elderly osteoporotic patients.
v. Lack of modern internal fixation devices.
vi. Unfamiliarity or inexperience with surgical techniques.
vii. Significant underlying medical disease

The goal of conservative treatment is not anatomical reduction of fracture fragments, but restoration of overall length and axial alignment.

The criteria for acceptable fracture reduction include

i. $< 7^0$ malalignment in frontal plane

ii. $< 10^0$ malalignment in sagittal plane

iii. Limb shortening < 1.5 cm.

iv. Articular incongruity < 2 mm

If a patient is being treated with conservative plaster cast, he/she must be closely observed for displacement of the fracture.

Weight bearing must not be allowed atleast for 8 weeks.

SURGICAL MANAGEMENT

a. INTRODUCTION:

In the past 25 years, various forms of treatment for fixation of fractures of distal tibia have evolved. The combination of a better understanding of fracture pattern, meticulous soft tissue handling, judicious use of antibiotics and improved imaging techniques has made different modes of minimally invasive fixation practically possible.

Since 1980, various studies have compared the results of various modes of fixation for periarticular fractures of distal tibia giving variable results.

The goals of operative treatment of periarticular fractures of distal tibia are

i. Anatomical Alignment

ii. Stable fixation

iii. Early Mobilization

iv. Early functional rehabilitation of the ankle.

Indications for operative management include

i. Displaced intraarticular fracture
ii. Patients with Multiple injuries
iii. Open fractures
iv. Associated vascular injuries requiring repair.
v. Severe ipsilateral limb injuries (patellar fracture, tibial plateau fracture)
vi. Major associated ligamentous injuries.
vii. Irreducible fracture.
viii. Pathological fracture

Contraindications to internal fixation include

i. Active infection
ii. Inadequate facilities
iii. Inexperienced surgeons

b. TIMING OF SURGERY

i. For open injury, compartment syndrome and vascular injury immediate treatment is needed

ii. For displaced unstable fractures surgery is done as early as the condition of patient permits

iii. After stabilization of neurosurgical, abdominal and thoracic injuries

iv. For critically ill patients, percutaneous fixation with temporary joint spanning external fixator

v. Definitive internal fixation is done after soft tissue swelling subsides and local skin condition permits.

c. PROCEDURE

Sequences in the surgical management of distal tibia fracture include

i. Restoration of articular surface
ii. Metaphyseal alignment.
iii. Defect filled with bone graft
iv. Early mobilization of joint.

I. Open Reduction Internal Fixation:

The fibula is fixed first through a postero lateral approach. Then the articular surface of tibia is reduced through an antero medial approach. Provisional K wires can be used to maintain articular reduction. Atleast a 7 cm skin bridge must be maintained between the two incisions. Narrow DCP, T Plate and Clover Leaf Plate with its tip cut can be used to fix distal tibial fractures. T and Clover Leaf plates act better in fractures with a large posterior fragment (Fig. 23,24).

Fig. 23: T Buttress plate.

Fig. 24: Clover Leaf Plate.

Since ORIF involved an extensile approach and open reduction, it led to the problems of wound dehiscence, infection and plate exposure (Fig. 25).

Fig. 25: Wound dehiscence after ORIF.

Since there was a high incidence of wound complications following ORIF the concept was then changed to a 2 stage delayed ORIF. ORIF is delayed until the skin and soft tissue condition improves, usually 10 to 21 days. During this period the fracture is kept distracted using a calcaneal pin traction or ankle spanning external fixator (Fig. 26,27).

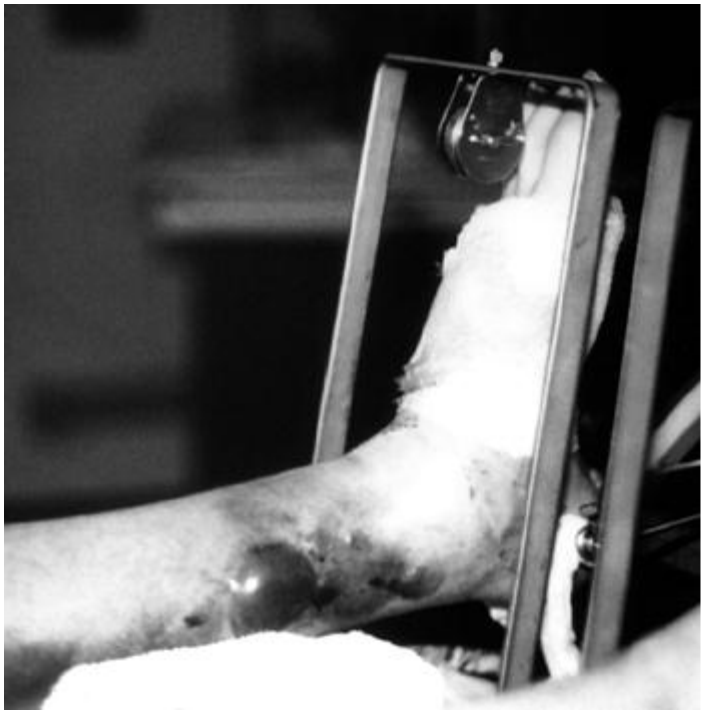


Fig. 26: Calcaneal pin traction on Bohler Braun frame.

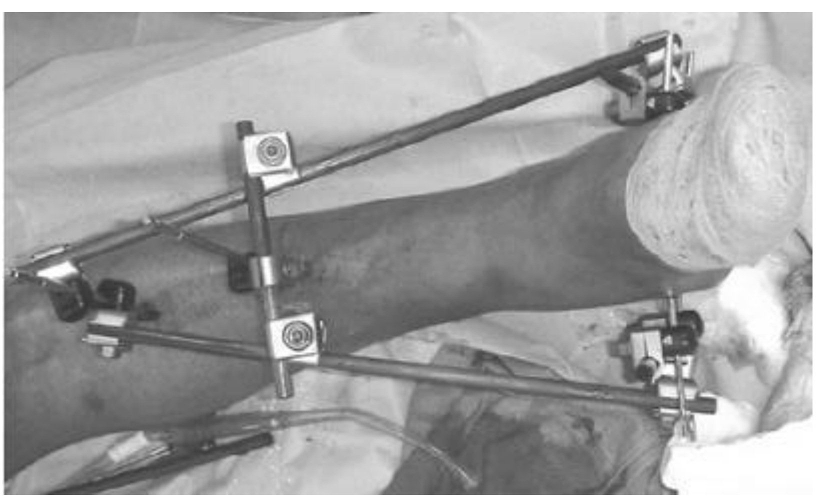


Fig. 27: Ankle Spanning External Fixator.

Nowadays medial buttress plate is used after minimal open reduction in which reduction is achieved using femoral distractor and articular surface is elevated through a small cortical window made in the anterior tibia (Fig. 28). The medial buttress plate is slid extra periosteally and fixed (Fig. 29).

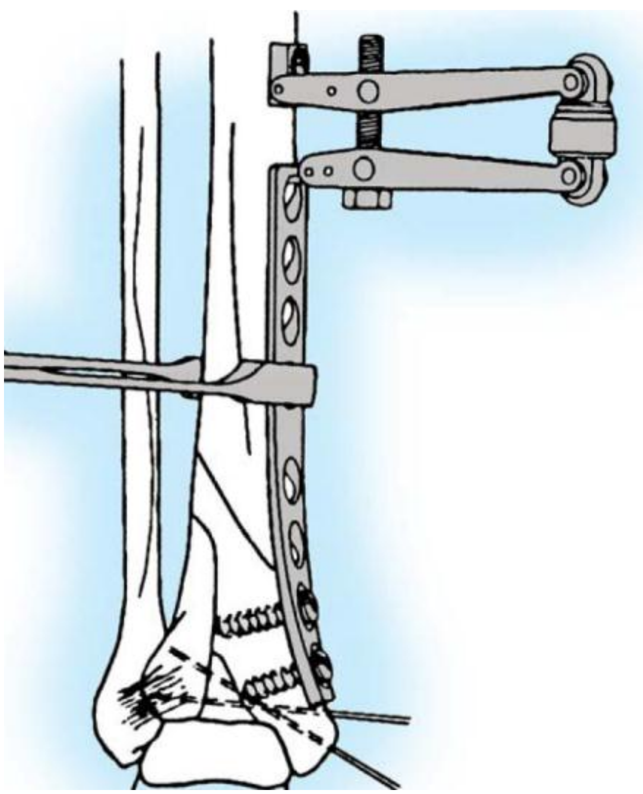


Fig. 28: Reduction done with the aid of femoral distractor.

Fig. 29: Medial and Antero Lateral Buttress Plating.

II. HYBRID EXTERNAL FIXATOR:

It is a Combination of wire (ilizarov) and pin fixation. It doesn't span the joints, so early mobilization can be done thus reducing the chances of joint stiffness.

Also early mobilization helps in good healing of the articular cartilage. It is also a more stable and less rigid fixation allowing axial micro motion thus favoring good bony union.

But the fixator is cumbersome and uncomfortable for the patient

(Fig. 30,31).

Fig. 30: Clinical Picture-Hybrid External Fixator.

Fig. 31: X Ray-Hybrid External Fixator.

III. INTRAMEDULLARY NAIL:

Intramedullary nailing has recently received more attention in the management of distal tibia fractures. These nails achieve more biological fixation than plates because they are load sharing implants. They enable greater soft tissue preservation.

But interlocking nail cannot be used in periarticular fractures of distal tibia due to the difficulty in achieving anatomical alignment by closed reduction and maintaining the reduction due to wide medullary canal (Fig.32).

To overcome this, newer designs of nails such as expert tibial nail has been introduced to deal with periarticular fractures of tibia.

Fig. 32: IL Nailing for Distal Tibia #.

IV. LOCKING COMPRESSION PLATE:

The screw holes in this plate have been specially designed to accept either a standard cortical screw with a hemi spherical head or a locking screw with a threaded head (Fig. 33).

It is used as a less invasive skeletal stabilization system by sliding the plate without disturbing the soft tissues. A locked screw plate construct can be compared to an implanted external fixation device.

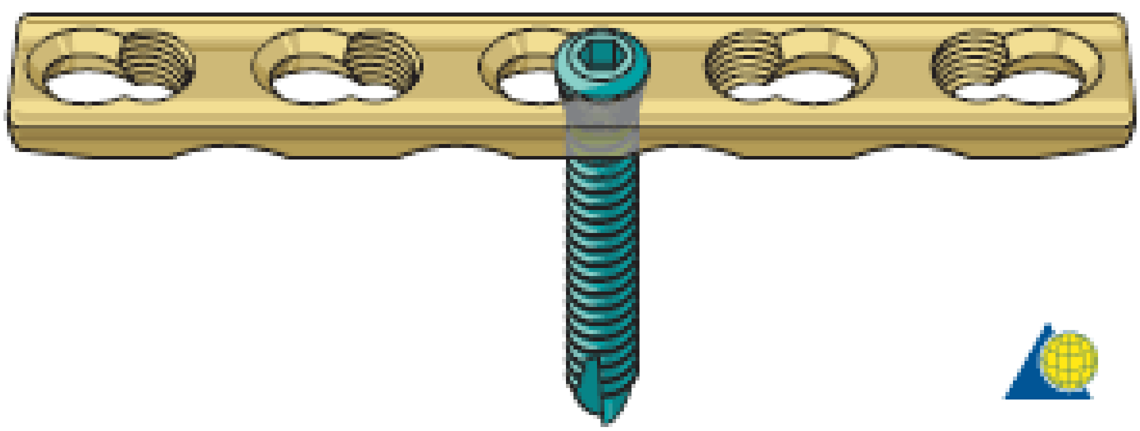


Fig. 33: Locking Compression Plate and Screw.

MIPO WITH LCP

a. Displaced type A fractures with minimal soft tissue injury

(Tscherne classification grade 0, grade 1)

These injuries may be reduced and fixed primarily, as a single stage procedure, if the soft tissues are in truly excellent condition.

A distractor or external fixator may help reduction (Fig. 34). Fibular reduction and fixation is the usual next step, but this reduction must be accurate, so that it does not prevent tibial reduction. Finally, the tibial plate is introduced with MIPO technique and final reduction of length, alignment and rotation is achieved.

Fig. 34: Preliminary External Fixation.

b. Grossly displaced fractures with severe, closed soft-tissue injury

(Tscherne classification, closed fracture grade 2 or 3)

It is generally advisable to proceed in two or more stages:

i. Closed reduction and joint bridging external fixation (Fig. 35)

ii. Definitive MIPO reconstruction after 5-10 days (wait for the appearance of skin wrinkles)

Fig. 35: Pins for joint bridging external fixator.

c. **compound distal tibial fractures**

Rarely, with open fractures of the distal tibia, if the fracture pattern is a simple type A1 fracture, direct reduction through the compound injury and absolute stability with compression plating is possible. Secondary soft-tissue reconstruction is still required. Often, definitive fracture stabilization should be delayed, until the time of definitive soft-tissue coverage.

The management includes several stages:

i. Emergency management: Wound debridement and lavage. Joint-bridging external fixation and stabilization of the fibula (if needed and soft tissues allow). Where possible, closure or coverage of any opening into the joint should be achieved.
ii. After 48 hours: Plan soft-tissue coverage (local or free flap).
iii. Definitive stabilization at the time of soft-tissue coverage.

11. PRE OPERATIVE PLANNING

INVESTIGATIONS – X Ray Ankle AP, Lateral views, CT Ankle with 3 Dimensional reconstruction.

i. Examine for signs of vascular injury, closed degloving, fracture blisters and compartment syndrome.
ii. Evaluate the soft tissue condition and plan the timing of surgery accordingly.
iii. Assess fracture pattern and degree of comminution.
iv. Assess articular surface involvement.
v. Evaluate the need for distraction to aid reduction.
vi. Patient factors like diabetes, peripheral vascular disease, alcoholism and smoking must be considered.

12. SURGICAL TECHNIQUE

Fibula or tibia first? Sequence of bone stabilization

In type 43-A1 fractures, the fibula may be fractured as well and needs to be stabilized.

For simple fibular fractures, this is usually done first with ORIF and stable plate fixation. Alternatively, for transverse fractures, consider a small diameter, flexible intramedullary nail. Fibular reduction helps realign the tibia fracture. The operation is completed by stable plate fixation of the tibia. Finally, bone grafting is performed if required.

Some fibular fractures are complex and reduction may be difficult. Their fixation will impede reconstruction of the tibia. In this situation, fibular ORIF is better after the tibia has been fixed. The syndesmotic ligaments are usually intact, so gross realignment of the fibula occurs with reduction and fixation of the tibia.

An option, which is attractive for comminuted fibular fractures, is to use a MIPO technique with a long bridging plate, or intramedullary fixation of the fibula with a small diameter, flexible nail. Fibular nailing is particularly applicable if the soft-tissue injury or complexity of the fracture makes extensive exposure for internal fixation hazardous.

Type A (extraarticular) fractures can often be reduced by ligamentotaxis alone with indirect manipulation. Direct exposure is therefore not often necessary. A properly contoured plate applied according to a good preoperative plan improves your chances of a good reduction as its shape itself acts as a reduction tool.

<u>Implant choice and plate contouring</u>

With MIPO plate constructs it is preferable to choose as long an implant as possible for the widest distribution of load at the fracture site (Fig. 36).

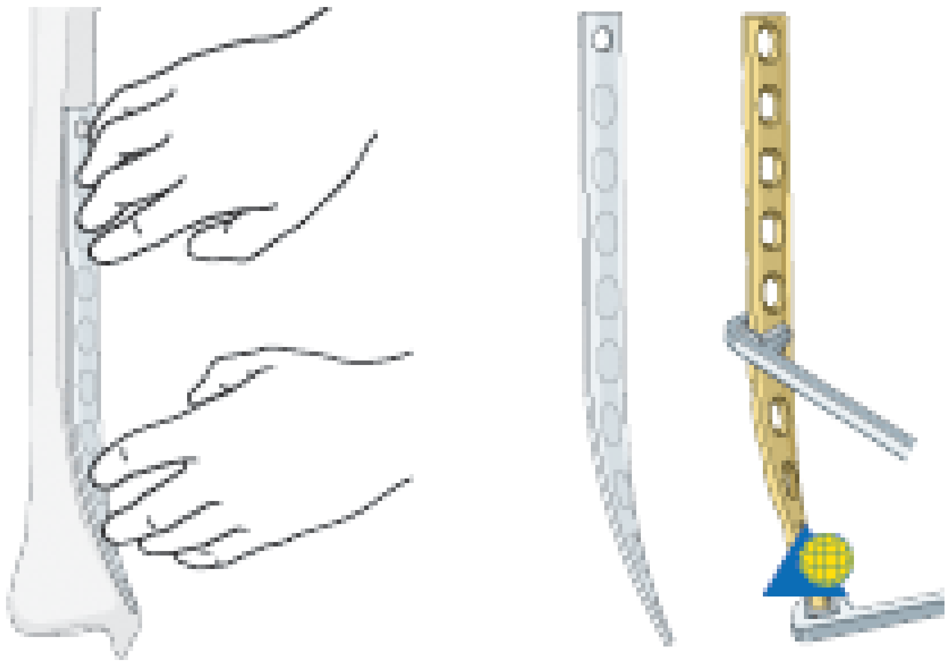


Fig. 36: Plate Contouring.

A variety of precontoured distal tibial plates are available. If such an implant is not available, it is important to contour the plate prior to insertion. A 3.5 or occasionally 4.5 mm standard or locking plate (LC-DCP or LCP) can often be used, but distal purchase may be compromised without a specially designed plate. For distal fractures and osteoporosis, locking head screws (LHS) may be more stable distally.

A non-contoured plate can be shaped prior to sterilisation, using a saw bone model as a template. First, determine the length of the plate from preoperative x-rays. Remember that the plate must be twisted to fit the distal tibia. As illustrated, the medial tibia distally lies closer to the sagittal plane while the shaft rotates externally above the metaphysis.

<u>Preliminary reduction</u>

An appropriately positioned distractor or external fixator can be a very helpful tool for reduction, especially for length and rotation (Fig. 37).

Where possible this should be positioned on the medial side of the leg.

Distraction can be used for the plate fixation of the fibula as first step (if not already fixed) and for the reduction of the tibia as a second step after previous fibular stabilization.

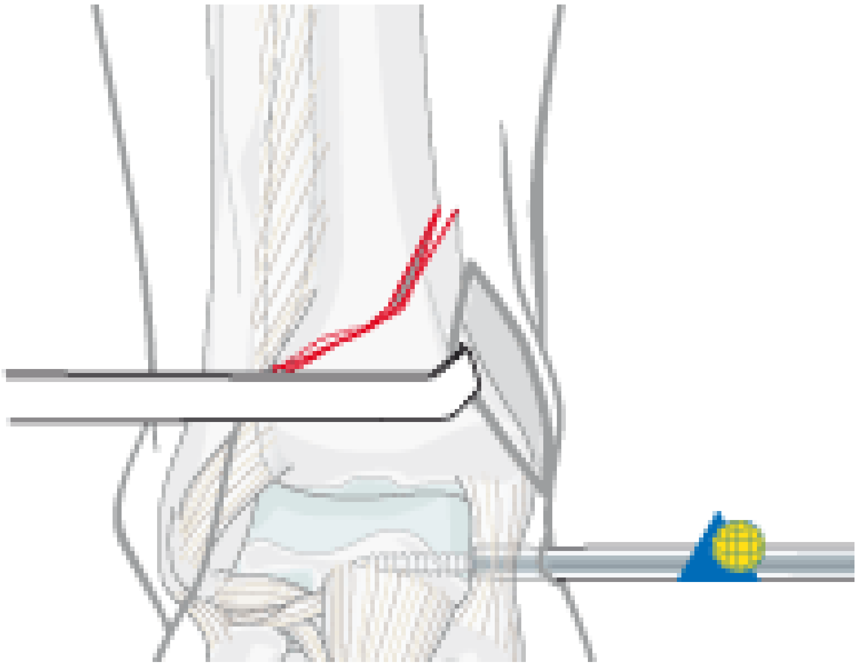


Fig. 37: Indirect reduction with a distractor

Schanz screws are positioned in safe zones of the tibial shaft and talar neck (or the calcaneal tuberosity). In case of previously applied

joint-bridging fixator, the already existing Schanz screws can be used.

a. <u>Plate insertion</u>

Tibial length and rotation are restored indirectly with distractor or external fixation. Angulation may be approximated in the same way, but is definitively corrected by plate application.

The plate is inserted through a distal medial oblique incision, after proximal tunneling with a blunt instrument. Depending on the fracture situation, the plate is usually positioned on the anteromedial aspect of the tibia (Fig. 38).

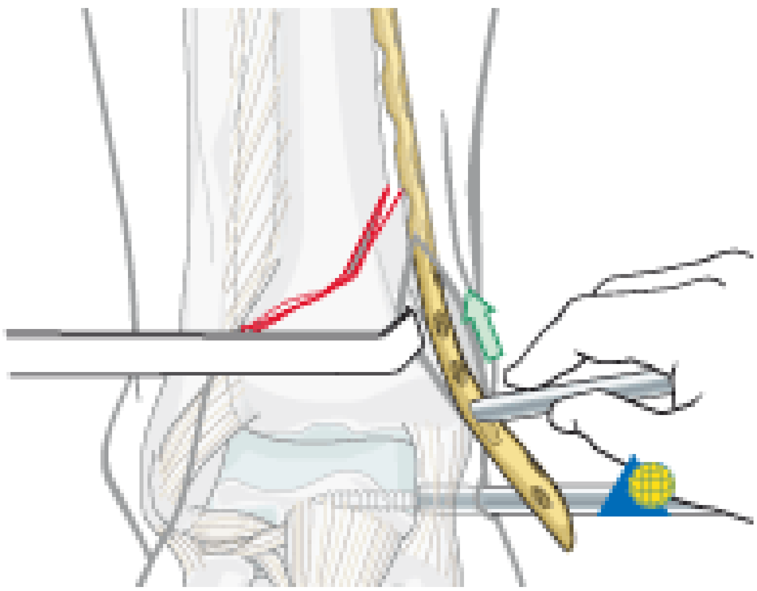


Fig. 38: Inserting the plate.

Proximally, above the fracture zone, a small incision (2-3 cm) will aid plate positioning. It is important that the plate and proximal screw be centered on the tibia, particularly if locking head screws (LHS) are planned.

Temporary fixation can be performed with K-wires through the screw holes to approximate final plate position before insertion of screws (Fig. 39).

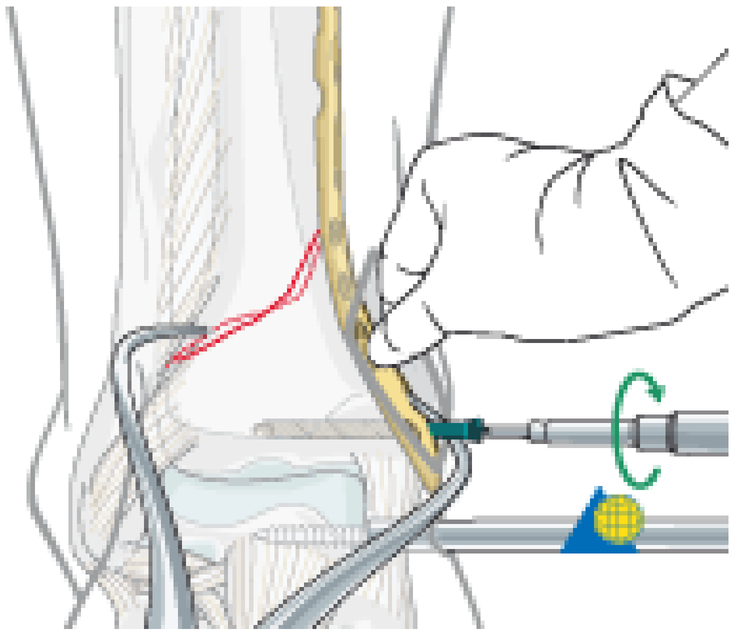


Fig. 39: Preliminary plate stabilization.

After achieving accurate position of the plate, insert a conventional cortical screw in one of the most distal plate holes to approximate the plate to the bone.

Alternatively, the plate can be manually pressed to the bone, to allow the insertion of a locking head screw instead of the conventional screw.

It is crucial that the plate is positioned very close to the bone, especially at the supramalleolar level, to prevent soft-tissue irritation by the plate.

b. <u>Applying compression</u>

For spiral and short oblique fracture patterns (A1.1 and A1.2) that are anatomically reduced, it is possible to place a lag screw through the plate to enhance the overall construct stability (Fig. 40).

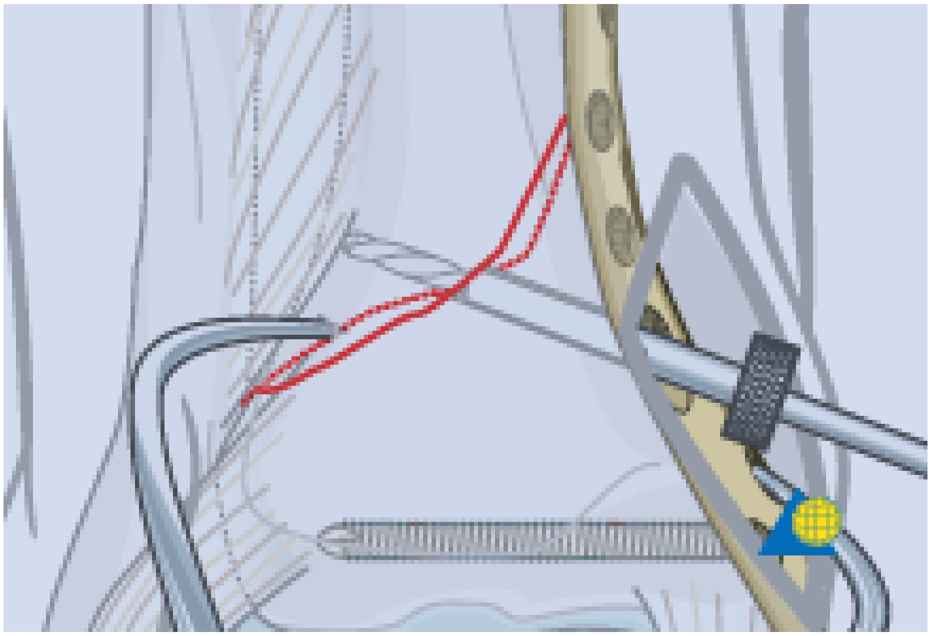


Fig. 40: Applying interfragmentary compression with a lag screw

It is possible to apply this screw in a percutaneous fashion under image intensifier control. Alternatively, depending on the fracture plane, the lag screw can be placed independent of the plate.

Compression with plate tension

For transverse type A1.3 fractures, fracture compression is achieved by applying tension with the plate, using eccentric placement of screws in non-locking holes, or an external tension device.

To ensure that the opposite side of the fracture remains compressed, it is necessary to add a subtle convex prebend to the implant at the fracture level.

c. **Finish plate fixation**

Further proximal and distal screw insertion is completed. The number and position of the screws required depends on the fracture pattern and bone quality. Ideally the concept of “balanced” fixation should be achieved (Fig. 41).

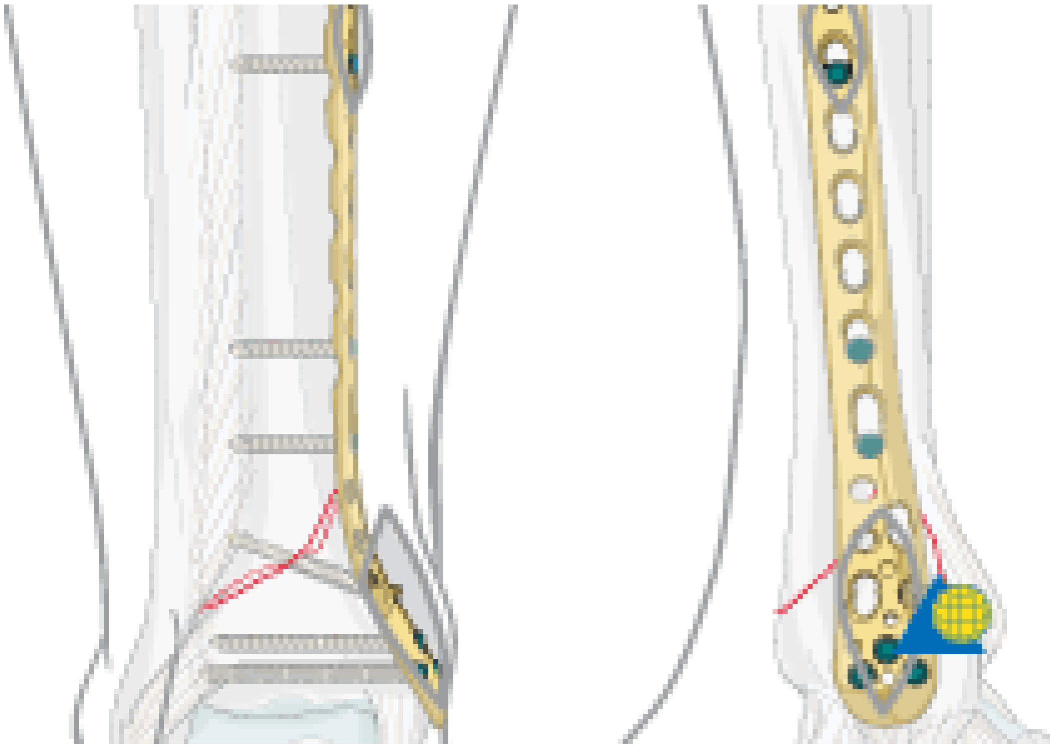


Fig. 41: Final fixation.

Usually, the metaphysis requires more screws (3-5) than the diaphysis (2-3). In osteoporotic bone, the number of screws must be increased on both sides of the fracture.

Locking head screws (LHS) may improve fixation in osteoporotic bone and short periarticular segments.

Wound closure

Atraumatic skin sutures are used for closure of screw insertion wounds. Occasionally, additional deeper sutures are needed for distal and proximal incisions (Fig. 42,43).

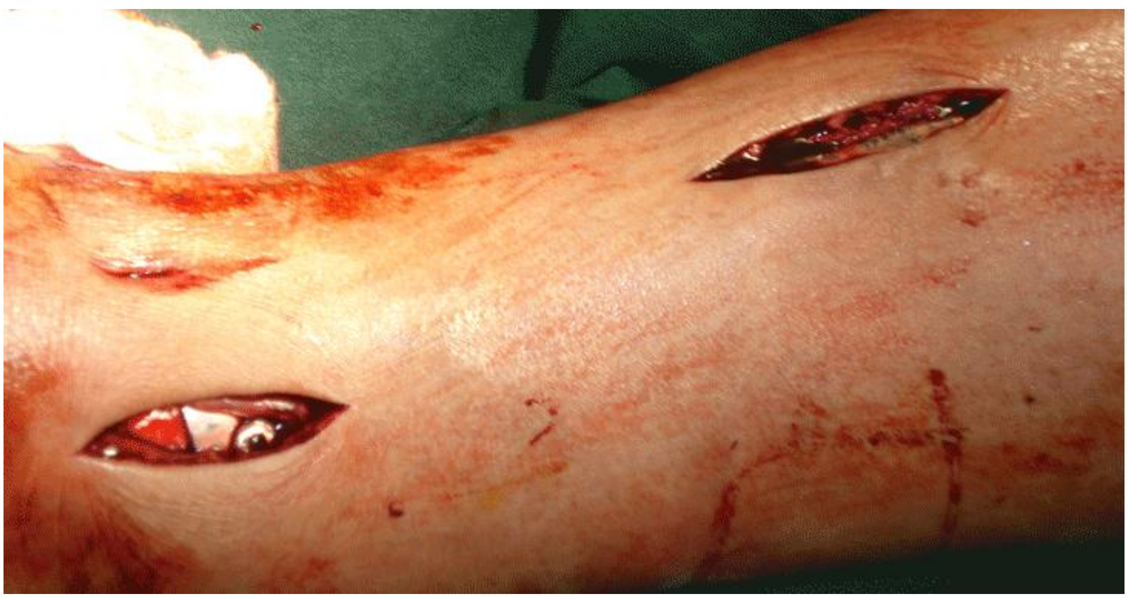


Fig. 42: Wound before closure.

Fig. 43: Wound after closure.

d. Final assessment

Anatomical reduction and fixation can be confirmed by taking X-rays at the end of the surgery.

It is important to check with imaging in both planes that a previously unrecognized split into the articular surface has not been displaced during this procedure.

13. COMPLICATIONS

The surgical treatment for periarticular fractures of distal tibia now has a better outcome than in the past because of improved implants. However the new methods are not without problems.

a. Complications of fractures:

i. Infection
ii. Vascular injuries
iii. Nerve injuries
iv. Nonunion
v. Malunion
vi. Missed ligamentous injuries
vii. Ankle stiffness

b. Complications of operative treatment:

i. Skin necrosis
ii. Incomplete reduction
iii. Incongruous reduction
iv. Loss of ankle motion
v. Infection

INFECTION:

The major drawback of operative fixation of peri articular fractures of distal tibia is the risk of infection.

However it should not exceed 5%. If wound drainage develops postoperatively, aggressive irrigation and debridement are indicated. Appropriate antibiotics should be given intravenously for 3 to 6 weeks.

In case of infection, the implants are preferably retained because stable infected fractures are easy to manage than unstable infected fractures. If the implant is loose, it should be removed and the fracture protected by external Fixation.

NONUNION:

It is much more common in conservatively treated cases than in surgically treated cases, owing in part to the poor blood supply to the distal tibia. Nonunion generally is due to presence of infection, unstable fixation, mechanical failure of the implant or any combination of these factors.

Treatment may be difficult owing to preexisting osteopenia, proximity to ankle joint and prior surgical procedures. Aseptic nonunion should be treated by repeat osteosynthesis. Septic nonunion should be treated with external stabilization.

POST TRAUMATIC ARTHRITIS:

The incidence of post traumatic arthritis is unknown. However incongruity of the joint surface is the leading cause of the early arthritis. This complication can be reduced by anatomical reduction and early mobilization. In patients with severe arthritis, ankle arthrodesis may be indicated. Factors such as age, range of motion, presence or absence of contractures and infection play a vital role in surgical decision making.

ANKLE STIFFNESS:

Perhaps the most common complication that occurs after tibial pilon fracture is loss of ankle motion. This complication results from damage to joint surface due to initial trauma or surgical exposure for fixation or both.

Arthrofibrosis of the ankle joint is thought to restrict ankle movement. Both immobilization after fracture and internal fixation can magnify these effects. Ankle immobilization for more than 3 weeks usually results in some degree of stiffness.

Early fixation of the fracture with minimal soft tissue handling and early mobilization increase the chance for an optimal outcome after periarticular fractures of distal tibia. Patients should attain full range of ankle movements 4 weeks postoperatively.

VASCULAR INJURIES:

The exact incidence of vascular injury accompanying distal tibial fracture is unknown. Vascular injuries can be caused by direct laceration (or) contusion of the artery or vein by fracture fragments or indirectly by stretching leading to initial damage, clinical examination for signs of ischemia with evaluation of pulses and motor and sensory function is essential.

MALUNION:

Malunion of tibial pilon fractures, distorts the articular surface of the ankle and produces much more severe disability. It should be corrected and internally fixed maintaining the articular surface.

ASSOCIATED LIGAMENTOUS INJURIES:

Concomitant ligamentous injuries to the ankle are common but are rarely diagnosed preoperatively. Initially non operative treatment is advocated as repair (or) reconstruction may produce further comminution, prolonged operation time and increases the risk of loss of ankle motion and infection.

Protected motion in conjunction with vigorous rehabilitation may obviate the need for late reconstructive surgery. If necessary late reconstruction should be done after the fracture has healed.

14. EVALUATION OF OUTCOME

We follow Tornetta et al scoring system for evaluation of the ankle joint.

GRADE	PAIN	ROM	ANGULATION
EXCELLENT	None	Dorsiflexion > 5^0 Plantarflexion > 30^0	<3^0 valgus
GOOD	Intermittent	Dorsiflexion 0 - 5^0 Plantarflexion 20 - 30^0	3-5^0 valgus < 3^0 varus
FAIR	Limiting daily Activities	Dorsiflexion -5 to 0^0 Plantarflexion 15-20^0	5-8^0 valgus 3-5^0 varus
POOR	Intractable	Dorsiflexion < -5^0 Plantarflexion < 15^0	>8^0 valgus >5^0 varus

Table 3: Tornetta et al scoring system.

15. MATERIALS AND METHODS

The period of surgery and follow up extends from September 2012 to September 2014.

Inclusion Criteria :

1. Age >/= 20 years
2. Closed, unstable fractures of distal tibia
3. Grade I & II compound distal tibia fractures
4. Fractures in which acceptable closed reduction can be achieved.

Exclusion Criteria :

1. Grade III Open fractures
2. Irreducible fracture deformity
3. Compartment Syndrome / poor local skin conditions
4. AO type C3 fractures (articular comminution).

The cases were analyzed as per the following criteria.

i. Age distribution
ii. Sex distribution
iii. Side of injury
iv. Mode of injury
v. Anatomy of fracture
vi. Associated injuries
vii. Open fractures
viii. Duration for surgery
ix. Time of union

a. <u>AGE DISTRIBUTION</u>

The age groups varied from 21 years to 51 years with the mean age of 36.5 years. Incidence of fracture was observed maximum between 30-40 years of age (Fig. 44).

Age Group	Number of cases	Percentage
20 – 30 years	3	16.7%
30 – 40 years	11	61%
40 – 50 years	3	16.7%
50 – 60 years	1	5%

Table 4: Age Distribution.

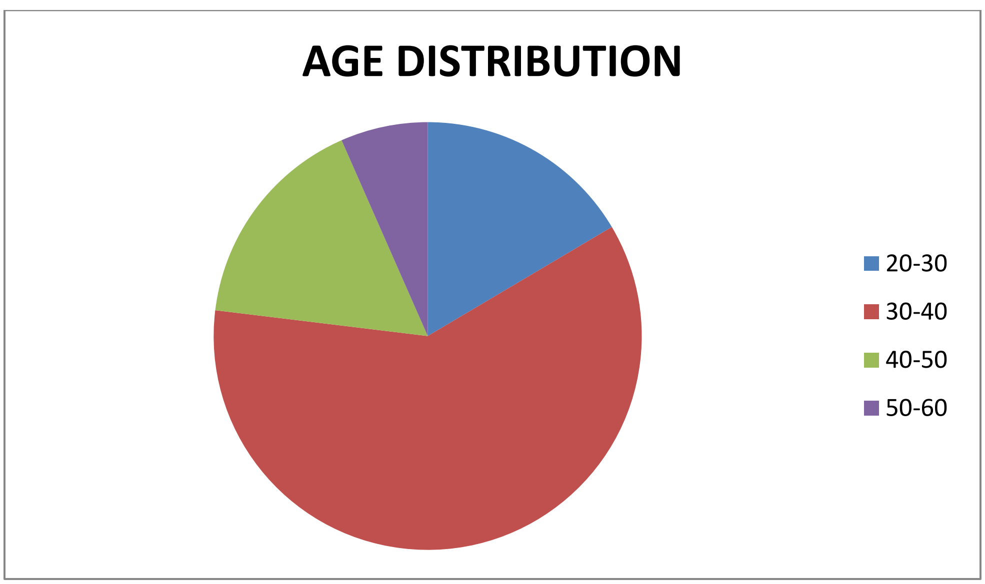


Fig. 44: Age Distribution.

b. SEX

Among the 18 cases, males were predominant with female to male ratio being 1:17 (Fig. 45).

Sex	Number of cases	Percentage
Male	17	95 %
Female	1	5 %

Table 5: Sex distribution.

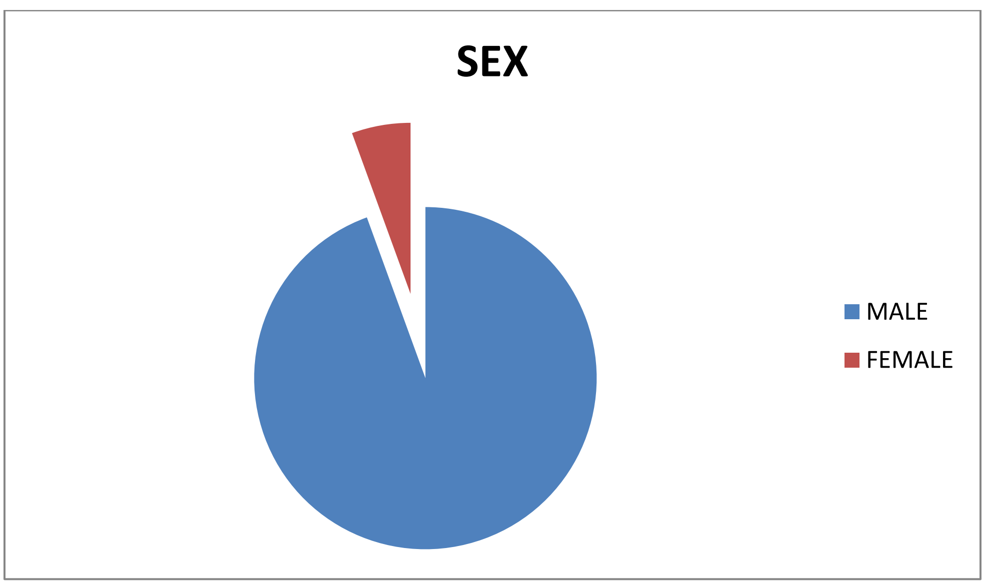


Fig. 45: Sex distribution.

c. **<u>SIDE OF INJURY:</u>**

Right side was common in our series in the ratio of 5:4 (Fig. 46).

Sex	Right	Left
Male Female	10 0	7 1
Total	10	8
Percentage	56%	44%

Table 6: Side of injury.

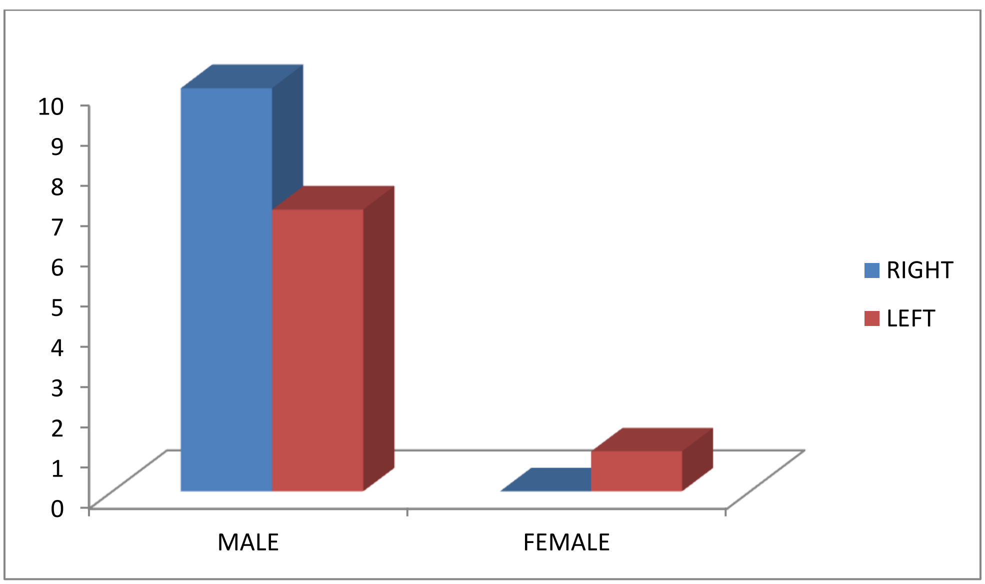


Fig. 46: Side of injury.

d. <u>MODE OF INJURY:</u>

The commonest mode of injury was road traffic accident (Fig. 47).

Mode of Injury	Number of cases	Percentage
RTA	18	100 %
Fall	0	0%

Table 7: Mode of injury.

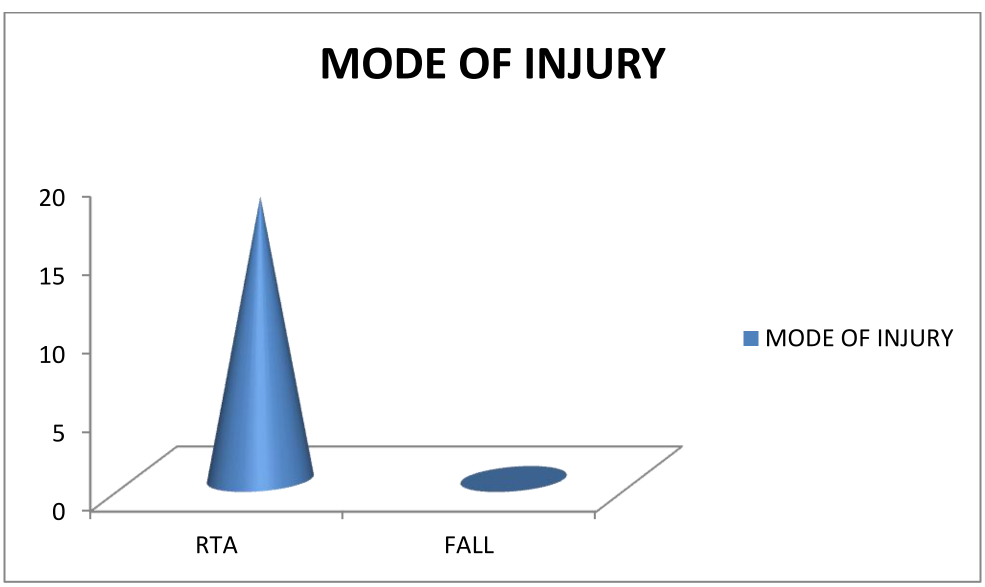


Fig. 47: Mode of injury.

e. ANATOMY

The study contains equal number of intra articular and extra articular fractures (Fig. 48).

SITE	Number of cases	Percentage
Intra Articular	9	50%
Extra Articular	9	50%

Table 8: Fracture Anatomy.

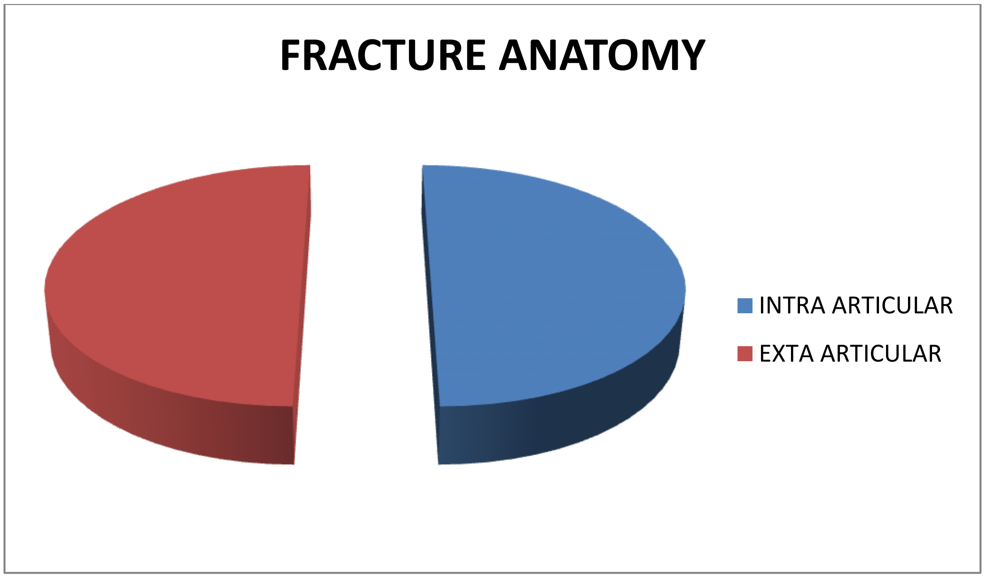


Fig. 48: Fracture Anatomy.

f. ASSOCIATED INJURIES

Eight among the eighteen cases had associated injuries (Fig. 49).

Head injury	– 2
Distal radius fractures	- 1
Patella fracture	- 4
Supracondylar fracture femur - 1	

Table 9: Associated injuries.

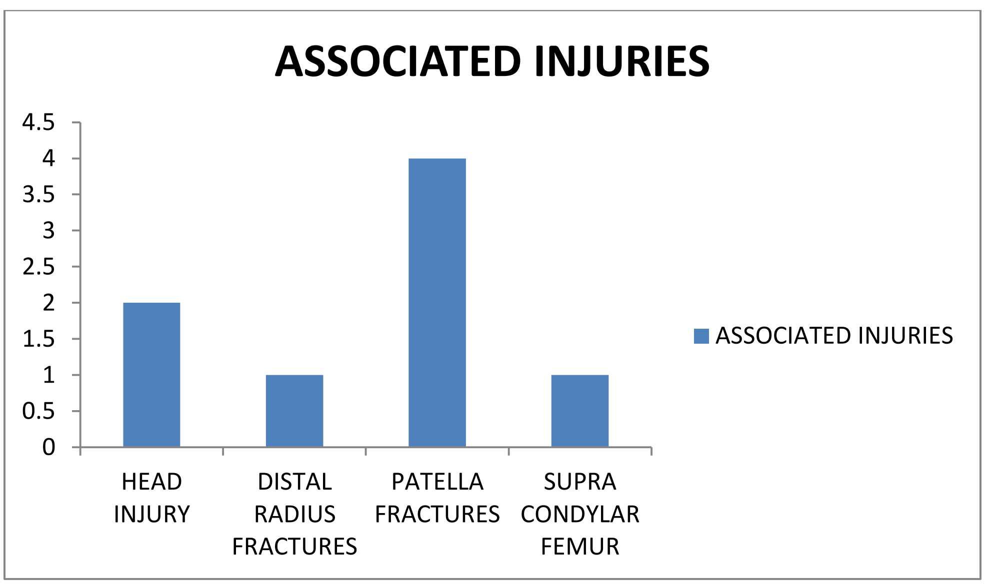


Fig. 49: Associated injuries.

g. <u>OPEN FRACTURES</u>

Eight out of the eighteen cases were open fractures (Fig. 50).

Type	**Number of cases**	**Percentage**
Simple	10	56 %
Compound Gr I	5	28 %
Compound Gr II	3	16 %

Table 10: Fracture type.

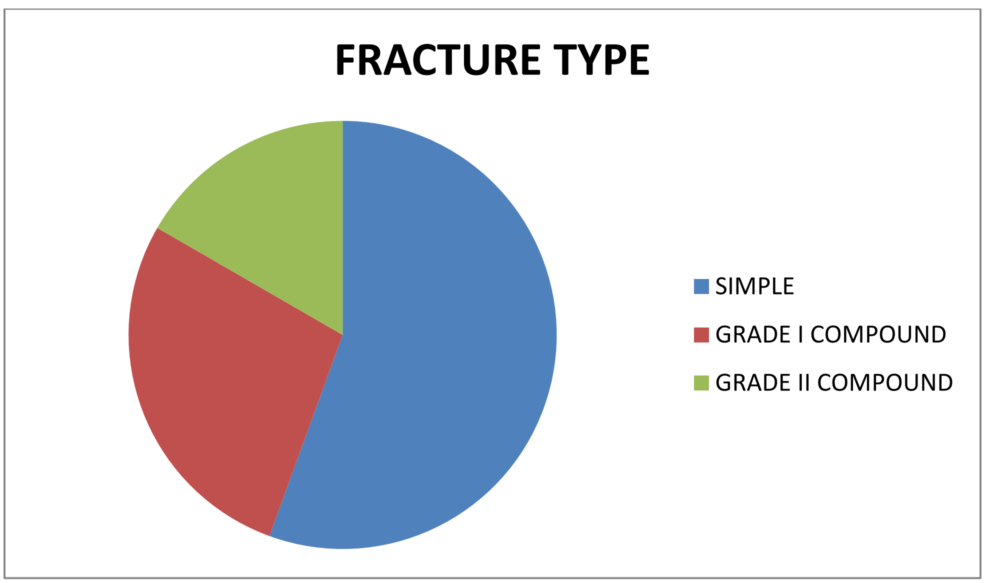


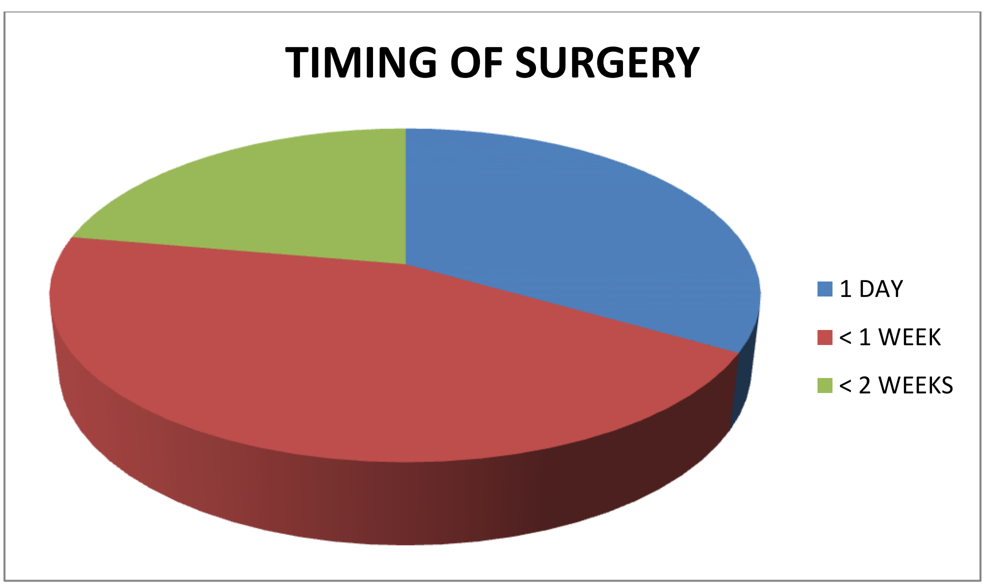
Fig. 50: Fracture type.

h. DURATION FOR SURGERY

There was a mean delay of 1 week for surgery (Fig. 51).

TIME INTERVAL	Number of cases	Percentage
1 day	**6**	**34**
< 1 week	**8**	**45**
<2 weeks	**4**	**21**

Table 11: Duration for surgery.



Fig, 51: Timing of surgery.

i. <u>TIME FOR UNION</u>

The mean time for bone union was 18 weeks (Fig. 52).

Time of union	Number of cases	Percentage
< 16 weeks	**11**	**66**
16-24 weeks	**4**	**23**

Table 12: Time for union.

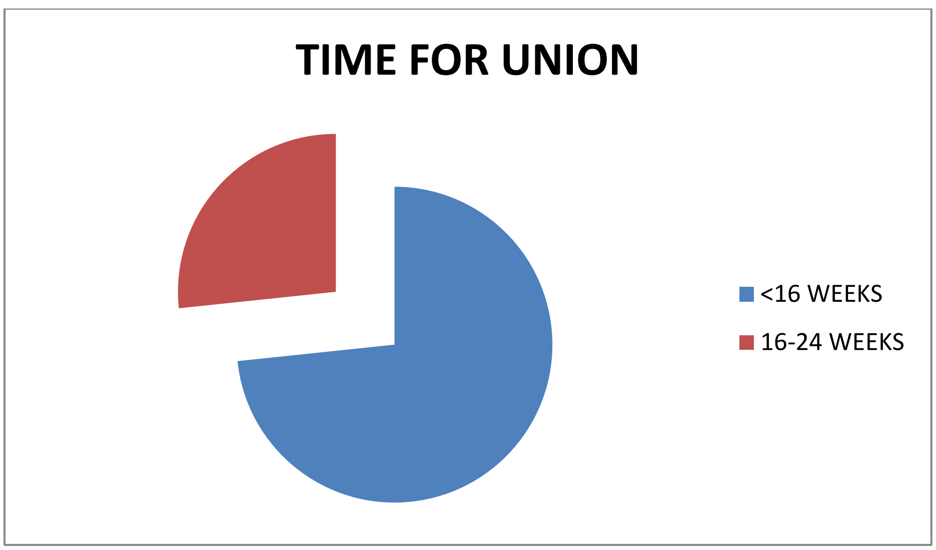


Fig. 52: Time for union.

OBSERVATIONS

i. 80**%** of the patients were between 30- 50 yrs.

ii. Both male and female were included , majority being males.

iii. Right side was common and no bilateral cases were studied.

iv. 44% of the fractures were compound injuries.

v. 44% of patients had associated injuries.

vi. Mean duration between injury and surgery was 1 week.

vii. Average time for bone union was 18 weeks.

viii. Average ankle dorsi flexion was 20 degrees.

ix. The results were excellent in 54%, good in 29% and fair in 17% of patients.

16. PROCEDURE

a. General Measures

All the patients were received in the casualty department and were resuscitated. After the general condition improved X rays AP and lateral views were taken. A detailed preoperative work up was done. All the cases were taken for surgical procedure as soon as possible. Those cases which were compound were initially treated with external fixator.

b. Post Operative Protocol:

Limb elevation is recommended for the first 2-5 postoperative days.

Physiotherapy with active assisted exercises is started immediately after operation.

Immobilization is not necessary.

Clinical and radiological follow-up is advised after 2, 6 and 12 weeks.

Based on the fracture consolidation, weight bearing can be progressively increased from 6-8 weeks with full weight bearing usually after 3 months.

Supervised rehabilitation with intermittent clinical and radiographic follow-up is advisable every 6-12 weeks until recovery reaches a plateau, typically 6-12 months after injury

Weight-bearing radiographs are preferable to assess articular cartilage thickness. Angular stable fixation may obscure signs of non-union for many months.

c. **Implant removal**

Implant removal may be necessary in cases of soft-tissue irritation by the implant (plate and screws). The best time for implant removal is after complete remodeling, usually at least 12 months after surgery.

In our study all the patients were followed up carefully looking for any complication every fortnightly till fracture healing; and there after every month up to 6 months; and every 6 months up to two years.

17. ANALYSIS OF FUNCTIONAL OUTCOME

Of the 18 patients included in the study one patient died in the late post operative period due to co-morbid medical conditions . Other patients are evaluated and studied for functional outcome (Fig. 53).

Normal bone union	–	15
Delayed union	–	2
Shortening	–	2
Joint stiffness	–	2
Valgus angulation	–	2
Marginal Skin necrosis	–	4
Deep infection	--	2

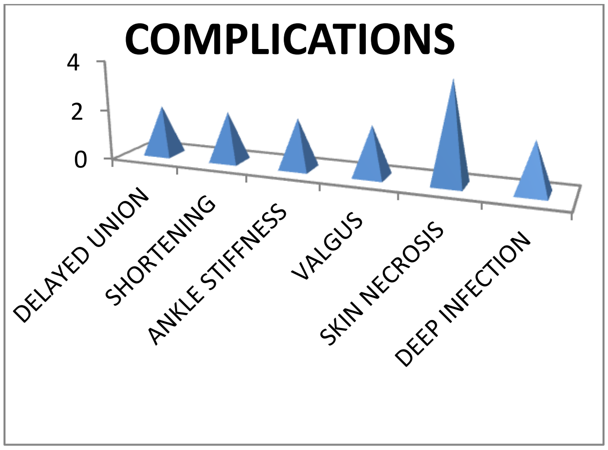


Fig. 53: Complications.

OVERALL RESULTS

The overall results of our study are much in favour of Minimally Invasive Plate Osteosynthesis for distal tibia fractures (Fig. 54).

The post operative pain was minimal and the post operative ankle function was very good.

Though we had marginal skin necrosis in 4 cases, they healed with regular dressings and none of the cases went for skin and soft tissue procedures.

GRADING	NO OF CASES	PERCENTAGE
EXCELLENT	9	54
GOOD	5	29
FAIR	3	17

Table 13: Overall results.

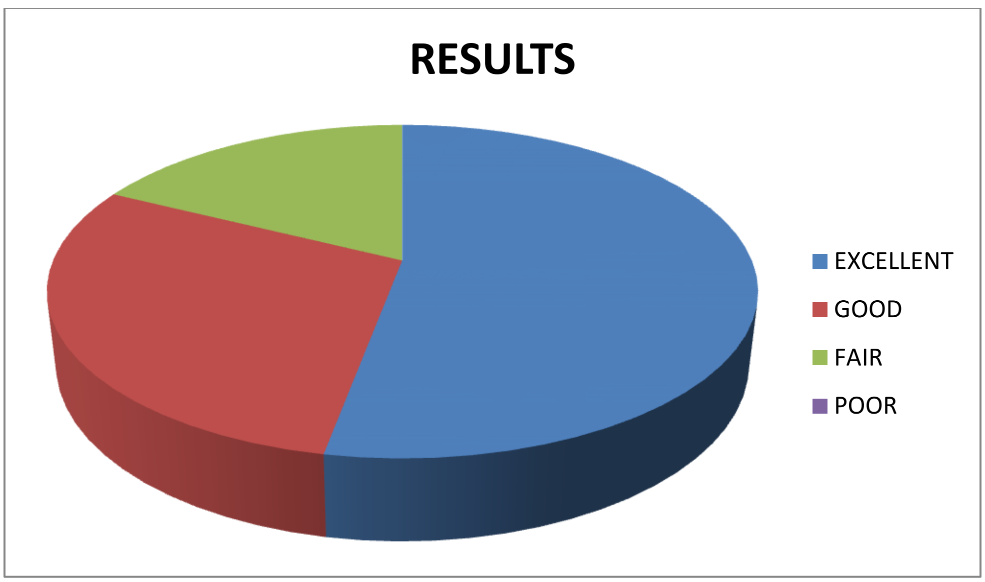


Fig. 54: Overall results.

18. DISCUSSION

Ruedi and Allgower[52] were the pioneers in open reduction and internal fixation (ORIF) of pilon fractures. They changed the outlook of management of distal tibia fractures in the early twentieth century. They achieved 74% good functional results following ORIF for distal tibia fractures. But it was later recognized that all their cases were results of low velocity injuries.[53,54] They could not reproduce similar results following the principles of open reduction internal fixation in high velocity injuries[55].

This led to the development of procedures that respect the soft tissue envelope. These biological methods of fixation are currently the procedures of choice in the challenging distal tibia fractures.

Two methods are currently popular in pilon fracture management.

- Hybrid external fixators are used in severely comminuted pilon fractures with significant soft tissue damage.

- Minimally invasive plate osteosynthesis (MIPO), is used in fractures without articular comminution and with minimal soft tissue damage.[55,56]

ORIF for pilon fractures has a high complication rate of

- nonunion 18%,
- mal-unions 42%.[63-67]
- superficial infections 20%,
- osteomyelitis 17%,
- post-traumatic osteoarthrosis 54%
- arthrodesis 27%,
- below knee amputation 6%,

Helfet et al.[68] introduced a 2 stage MIPO for distal tibia fractures.

Stage 1 – fibular internal fixation and spanning external fixation of tibia

Stage 2 – limited ORIF for distal tibia.

40% of their cases were intra articular fractures

60% were extra articular fractures.

They had a 10% incidence of $>5^0$ valgus deformity and

a 10% incidence of $> 10^0$ recurvatum deformity.

The average ankle dorsiflexion achieved was 14º and plantar flexion was 42º.

Ours is a prospective study of 18 cases of distal tibial fractures treated with MIPO using specially designed distal tibial LCP.

We did medial plating in all cases.

The age group of our patients varied from 21 years to 51 years with the mean age of 36.5 years.

95% of our patients were males.

50% of our cases were extra articular and 50% intra articular fractures.

44% of the fractures were compound in nature.

44% of our cases had associated injuries.

We did not perform preliminary external fixation as in the Helfet et al.'s[68] series. We selected patients with apparently good soft tissue condition. Thus a single stage MIPO protocol was followed thereby providing a shorter duration of treatment. This single stage procedure reduced the surgical insult thus preventing complications like wound dehiscence, sepsis, delayed or non-union. The MIPO technique enables a bridging fixation without disturbing the comminuted segments and the surrounding soft tissue.

We used an anatomically prebent plate unlike Helfet et al.[68] thus achieving stronger fixation in the metaphyseal region as it permitted insertion of 2 or 3 cancellous 6.5 mm screws in the small distal segment.

The mean duration between injury and surgery in our study was 1 week.

The average time for bone union was 18 weeks.

We achieved 54% excellent, 29% good and 17% fair results.

The average ankle dorsiflexion was 20^0.

The incidence of complications

- Delayed union – 11%
- Shortening - 11%
- Ankle stiffness – 11%
- Valgus angulation- 11%
- Marginal skin necrosis - 22%
- Deep infection - 11%

All our cases were followed for a mean period of 14.2 months averaging from 28 months to 4 months.

Out of the 18 cases bony union was obtained in 17 cases (one patient died during follow up) .

2 cases had delayed union. The prime reason for delayed union in both the cases was intact fibula which made the fracture site to distract.

There was no case of implant failure.

The average time of bony union was 18 weeks compared to 18.5 weeks by Shrestha et al and 21.2 weeks by Hasenboehler et al.

There were 2 cases that were complicated by ankle stiffness. Both the patients had poor compliance in the post operative period which was the result of ankle stiffness.

Shortening of <2 cm was seen in two patients both of which had highly communited distal tibial fractures with diaphyseal extension. They were managed with heel raise.

Though we had marginal skin necrosis in 4 cases, they healed with regular dressings and none of the cases went for skin and soft tissue procedures.

Thus, with regards to functional outcome, our results are comparable to those of Shrestha et al[1] (Table 14). These results were possible because of proper case selection, perfect articular reconstruction and meticulous soft tissue handling.

S.NO.	CRITERIA	CURRENT STUDY	SHRESTHA ET AL[1]	HASENBOEHLER ET AL[9]
1	STUDY TYPE	PROSPECTIVE	PROSPECTIVE	RETROSPECTIVE
2	NO. OF CASES	18	20	32
3	OPEN FRACTURES	8 (44%)	8 (40%)	13 (40.6%)
4	INTRA ARTICULAR #	9 (50%)	2 (10%)	12 (37.5%)
5	SURGERY DELAY	7 DAYS	4.45 DAYS	6 DAYS
6	UNION TIME	18 WEEKS	18.5 WEEKS	21.2 WEEKS
7	DELAYED UNION	2 (11%)	1 (5%)	6 (18.75%)
8	NON UNION	0	0	2 (6%)
9	VALGUS	2 (11%)	2 (10%)	4 (12.5%)
10	SKIN NECROSIS	4 (22%)	2 (10%)	7 (21.9%)
11	DEEP INFECTION	2 (11%)	1 (5%)	4 (12.5%)
12	SHORTENING	2 (11%)	2 (10%)	3 (9%)
13	ANKLE STIFFNESS	2 (11%)	2 (10%)	4 (12.5%)

Table 14: COMPARISON WITH OTHER STUDIES.

19. CONCLUSION

To summarize,

The advantages of locking compression plate are

1. provides a biomechanicaly stable construct
2. does not endanger periosteal blood supply
3. preserves the fracture heamatoma

The advantages of Minimally Invasive Plating are

1. fracture fixation without disturbing the soft tissue cover
2. less chances of infection
3. early mobilization of the adjacent joint.

Thus minimally invasive plate osteosynthesis using LCP proves to be a safer technique in the management of distal tibial fractures without intra-articular comminution by providing good fracture healing, enabling rapid functional recovery, and avoiding major skin complications.

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21. <u>ILLUSTRATIONS</u>

CASE 1 :

PRE OP X RAYS

POST OP X RAYS

POST OP WOUND

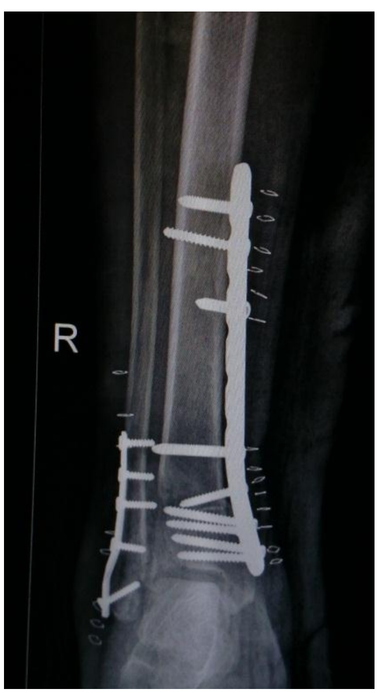
AFTER 14 WEEKS

FRACTURE UNION

CASE 2 :

PRE OP X RAYS

POST OP X RAYS



POST OP RANGE OF MOVEMENTS


AFTER 16 WEEKS


CASE 3 :

PRE OP XRAY


POST OP X RAY


AFTER 14 WEEKS

HEALED SCAR

22. PROFORMA

TOPIC : A CASE STUDY OF DISTAL TIBIAL FRACTURES MANAGED WITH LOCKING COMPRESSION PLATE USING MIPO TECHNIQUE

Dr. P.VANAJ KUMAR

NAME: AGE / SEX :

I.P.NO: D.O.A :

D.O.S :

ADDRESS : D.O.D :

Presenting complaints :

If female whether Pre- / Post-menopausal:

Examination:

X-Ray :

Diagnosis :

Treatment:

Post op protocol:

Advice on discharge:

FOLLOW-UP NOTES

Time since surgery	X-Ray Findings	Range of Movements	Functional Assessment	Any complications

Special Points:

23. MASTER CHART

S. NO	NAME	AGE/ SEX	I.P. NO	DIAGNOSIS	ASS. INJURY	TREATMENT	OTHER PROCEDURE	TIME FOR UNION	ANKLE MOVEMENTS		COMPLICATIONS	RESULT
									DF	PF		
1	Joseph raj	38/M	37630	Simple pilon # rt.	Head Injury	MIPO with LCP ORIF fibula	-	22 weeks	30	40	-	Excellent
2	Kaveri samy	32/M	28621	CompGr.II Distal tibia # lt. Rt	-	MIPO with LCP	-	28 weeks	20	40	Wound infection Delayed union	Good
3	Ganesan	34/M	51085	CompGr.I Distal tibia # lt. Lt	Verti cal patella #	MIPO with LCP	OR & IF with 4mm malleolar screw for patella	16 weeks	20	40	Skin necrosis	Excellent
4	Uthaminathan	21/M	39610	Comp.Gr.II tibial pilon # rt.	Comp.Gr. IIIB SC # femur	MIPO with LCP ORIF fibula	OR & IF of SC # with LCP	24 weeks	20	40	Wound infection	Good
5	Antony raj	33/M	29781	Simple distal BB leg # lt.	-	MIPO with LCP	-	14 weeks	20	40	-	Excellent
6	Ranjitham	36/F	38210	Simple pilon # lt.	-	MIPO with LCP ORIF fibula	-	16 weeks	20	40	-	Excellent

7	David rajan	27/M	22655	Simple tibial pilon # rt.	Communited patella #	MIPO with LCP	Patellectomy	14 weeks	20 40	-	Excellent
8	Kadarkarai	45/M	23782	CompGr.I distal tibia# rt.	Distal radius #	MIPO with LCP	CR & IF RADIUS	16 weeks	20 40	Skin necrosis	Good
9	Gomathinayagam	40/M	31274	Simple tibial pilon # lt.	Communited patella #	MIPO with LCP	OR & IF of patella	20 weeks	20 40	-	Excellent
10	Muthuraj	36/M	29241	Simple distal BB leg # lt.	-	MIPO with LCP	-	14 weeks	20 30	-	Excellent
11	Antony	22/M	30081	Simple distal BB leg # lt.	-	MIPO with LCP ORIF fibula	-	16 weeks	20 40	5 degree Valgus	Fair
12	Marudhu	45/M	32817	Simple leg # distal BB leg rt.	-	K wire for fibula MIPO with LCP		-	-	Death	
13	Saravanan	38/M	36281	CompGr.I Pilon # lt.	-	MIPO with LCP ORIF fibula	-	32 weeks	10 20	Ankle Stiffness delayed union	Fair
14	mariappan hameed	35/M	31181	Comp.GrI distal BB leg rt.t	-	MIPO with LCP	-	18 weeks	10 40	Skin necrosis	Good
15	Kannan	36/M	28121	Simple tibial Pilon # rt. Type VI	-	MIPO with LCP ORIF fibula	-	14 weeks	20 40	Shortening 0.5 cm	Good

16	Vembu	42/M	30012	Simple tibial pilon # rt.	-	MIPO with LCP ORIF fibula	-	14 weeks	20	40	Skin necrosis	Excellent
17	Paulraj	40/M	27181	Comp.Gr.I tibial pilon # rt.	Commu nited patella #	MIPO with LCP	OR & IF of patella with TBW	14 weeks	10	30	5^{0} valgus Shortening 1 cm	Fair
18	manikand an	51/M	21261	CompGr.II BB leg # rt.	-	MIPO with LCP		14 weeks	20	40	-	Excellent